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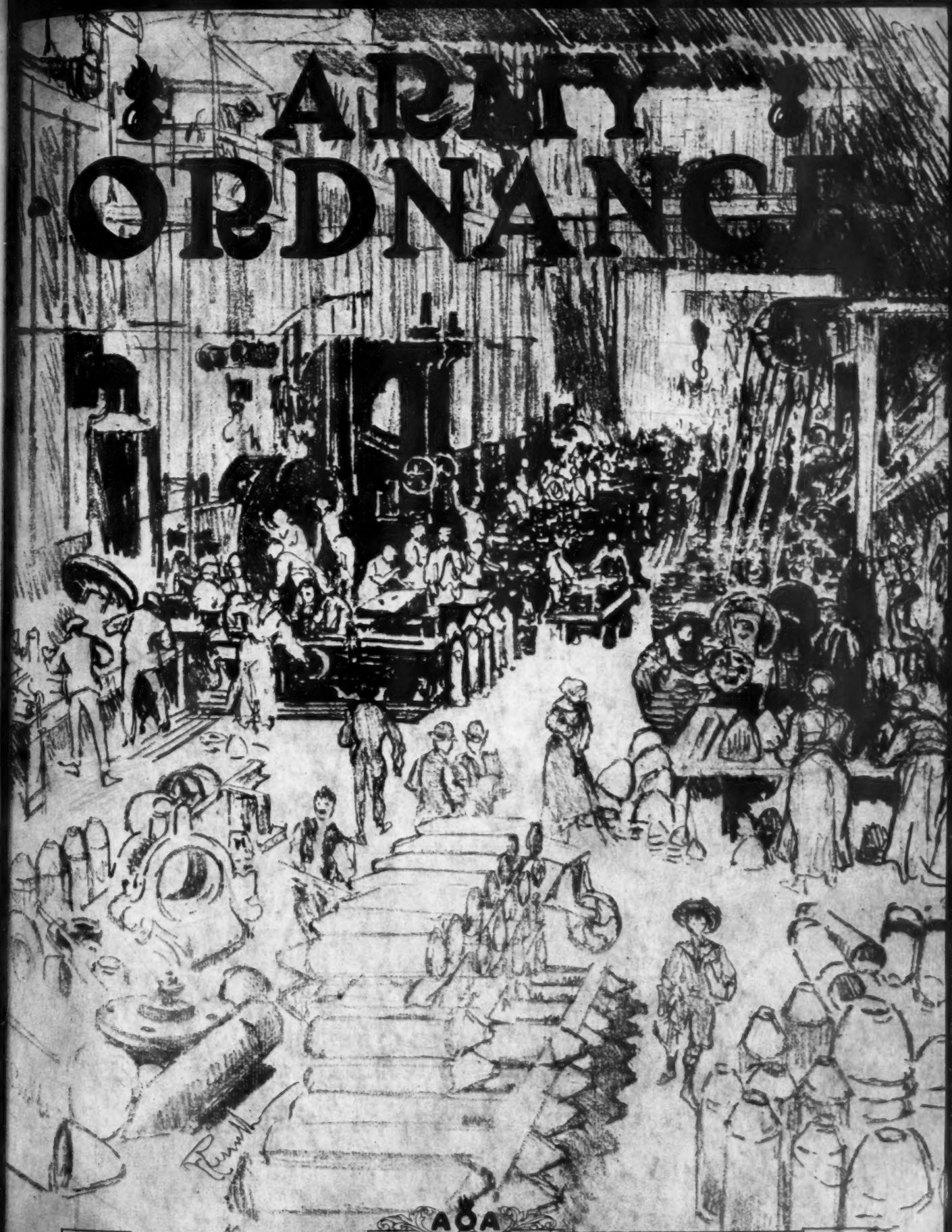

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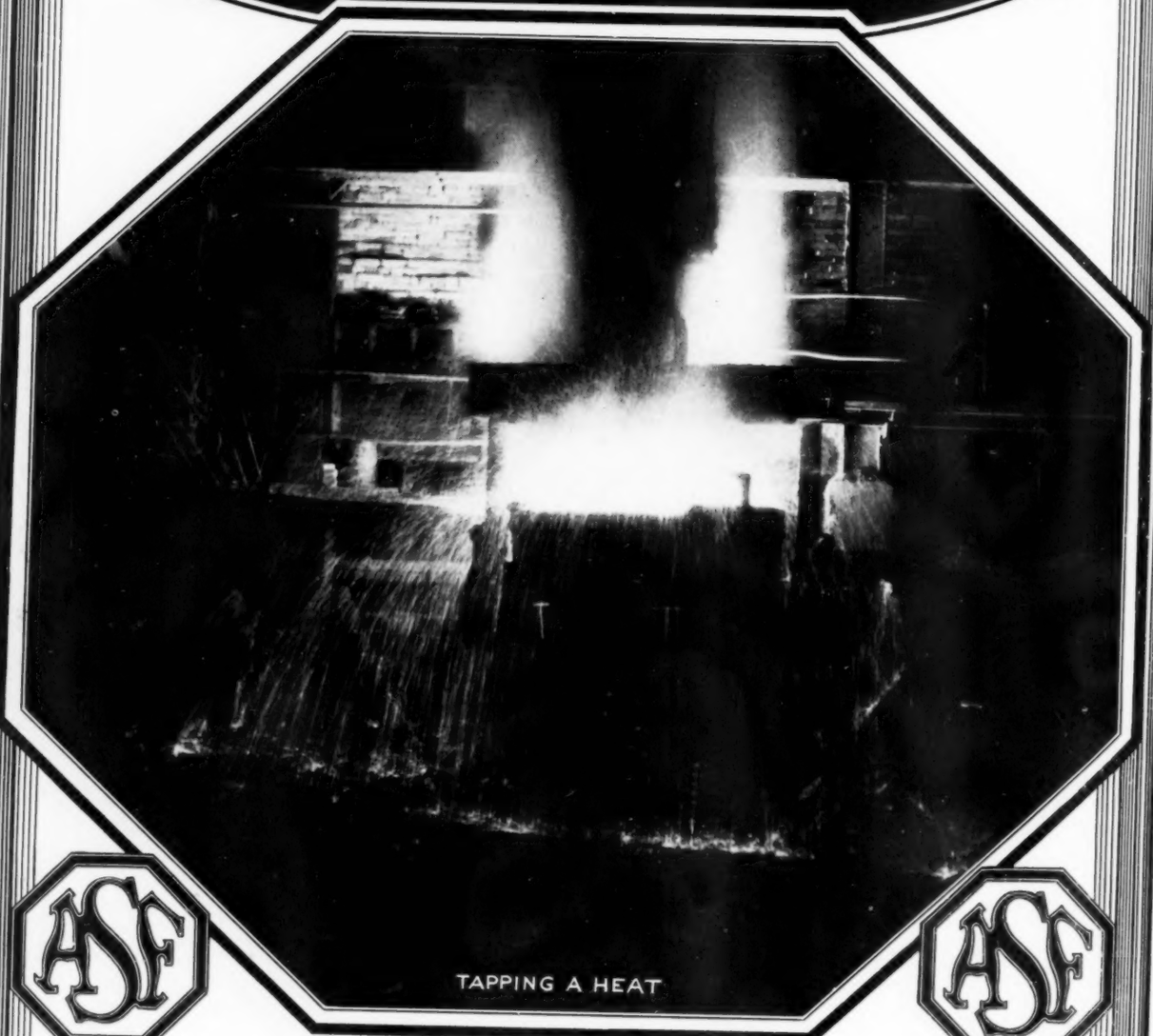

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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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"The industrial war plan must conform to the living body of industry—to its customs, practices, organization and character. No human mind can grasp every detail. It can only be developed by years of labor and research. Occupying the space between the continuously changing body of industry and the intermittently changing war plan, it must slowly shape itself to each."

—Patrick J. Hurley, Secretary of War.

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

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ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers and manufacturers in civil life and the regular and reserve officers of the Ordnance Department.

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President of the Army Ordnance Association since 1919; The Assistant Secretary of War and Director of Munitions 1917-1921; Appointed by President Hoover a Brigadier General in the Reserve Corps, January 23, 1931.

ARMY ORDNANCE

VOL. XI MARCH-APRIL, 1931 No. 65

Industrial Mobilization In Russia

The Military Supply System Before and During the World War

By A. M. Platoff*

BY the way of explanation rather than excuse, attention is called to the fact that more than sixteen years have elapsed since the memorable days of August, 1914; and with their passing many facts and events have faded from memory. While other countries have their war records available, where the student of those days may verify his investigations, in the case of Russia it is impossible, at least for the author, to check such data. However, an earnest effort has been made to recollect the events and figures, and in some instances these have been checked with former associates in procurement work for Russia. In addition, facts and data have been used freely from "War and Industry" by Gen. E. Hermonius, the war-time chairman of the Main Russian Procurement Committee in London, and from "Memories" by Gen. A. S. Loukomsky, the war-time Assistant Minister of War in charge of all procurement work in Russia, and later the Quartermaster General on the staff of the commander-in-chief, the Czar. The author's own part in procurement work was much more modest: after over a year with the 6th division on the front, being recalled as an ordnance engineer, for several months he was business manager of the Ekaterinoslav District Defense Council, and later on was engaged in procurement work in the United States for the Russian government until the Bolshevist revolution.

In gaining experience for future work we profit more by mistakes than by success. The success lulls us to self-flattering, while failure forces us to think in order to eliminate possible repetition of the same errors. We may profit by studying our own mistakes or the mistakes of others; while our own mistakes bring us bitterness of failure, the mistakes of others give us lessons just as valuable but without taste of bitterness: that is why the study of the collapse of the huge Russian Army during the third year of the war is so valuable, offering as it does an opportunity to avoid making similar mistakes.

THE similarities between the United States and Russia are singularly great. The United States has a region of Great Lakes in the North, connected by canals to other navigable rivers. Russia, also, has a region of great lakes comprising the lakes Ladoga, Onega, Ilmen, and Chud, all inter-connected either by navigable rivers or by a system of canals, and connected to the Baltic Sea and to the Volga system. The main stream in the United States is the Mississippi-Missouri flowing from north to south into the comparatively closed Mexican Gulf; Russia's main stream is the Volga-Oka flowing also from north to south into an inland sea, the Caspian. The main industrial region of the United States is situated east of the Mississippi Valley and south of the Great Lakes facing the Atlantic Ocean. Russia's industrial region is situated west of the Volga River and also south of her great lakes facing in the direction of the same Atlantic Ocean. The heart of the steel industry in the United States is in Pennsylvania with its coal region; the center of the steel industry in Russia is in the Donetz Basin with its coal and ore mines, approximately in the same relative position to her main stream and great lakes. West of the Mississippi Valley is the vast "Far West" rich in agriculture but industrially a less developed portion of the United States; east of the Volga River there lies the vast Siberia, the granary of the world, immensely rich in natural resources, but industrially developed to a very small extent. It appears that both countries are symmetrical, both facing Western Europe, the source of our civilization.

The reason for such symmetry is quite obvious: western civilization was brought to America by the early colonists from Western Europe so that the first settlements here were confined to a row of maritime colonies along the shores of the Atlantic Ocean. The same western civilization was penetrating Russia from the same Western Europe at first slowly, and then, since the reign of Peter the Great, at a very rapid pace, converting a semi-Asiatic state into a powerful member of the family of the civilized nations.

PETER the Great, the great political reformer and modernizer of Russia, was about as uncompromising in his effort to "make a window into Europe" as the Bolsheviki are uncompromizing in their effort to convert Russia and the whole world into communistic religion. In both cases the blood of those who did not and do not agree with the new order of things was and is shed most relentlessly.

The first and most important effort of Peter the Great was to build up the military strength of Russia in order that he might secure an unfreezing sea port. While he succeeded in this problem and, even during his own lifetime, saw his new armies defeating the military dominance of Sweden under Charles the Twelfth, his ideas and conceptions are reflected in the whole subsequent military and political history of Russia. Even in the causes of the latest revolution, Russian military leaders were limited by a set of conditions established by Peter the Great.

There was not a regular army in the old Moscovite Czardom. In event of a war, and there were plenty of wars in the life of Russia, the Czar called upon the *opolchenie* i. e., his nobility with their retinues of warriors, both footmen and horsemen. As late as the end of the Tartar Wars, towards the middle of the Sixteenth Century, the chief weapons were the sword, the lance and the bows and arrows. It is true, there were rudiments of artillery num-

*Mechanical Engineer. Formerly Lieutenant Colonel, Russian Army. Major, Ordnance Reserve, U. S. Army.

bering a few ordnance pieces bought abroad in Europe. As a relic of the artillery of those days there is the "Czar-Pushka," a huge cannon with 28-inch bore, remaining even now in the Kremlin in Moscow, as a curiosity of a past age. With the first Czars of the new dynasty, the Romanoffs, as a result of a series of wars with Poland, a new branch was introduced into the Russian armed forces, a standing semi-regular corps of *Streltzi* consisting of several hundred, sometimes several thousand, footmen armed with muskets. This corps of *Streltzi* was stationed in Moscow, and being the only standing army in Russia, it early became a powerful tool in the hands of ambitious statesmen trying to obtain personal gain through influencing the succession of the throne of the Czars.

The most remarkable attempt to eliminate the rightful Czar, then the sixteen-year-old Peter, resulted in severe persecution of the *Streltzi,* wholesale executions and eventually a complete annihilation of this corps of pretorians. In his fight against the rebellious *Streltzi* Peter the Great used several regiments of *poteshni* composed of young men, his playmates during an enforced exile in a suburban village by his ambitious sister, Sophia. These regiments, the progenitors of the huge Russian armies of the World War, were organized and drilled, after the fashion of the best European armies of those days, by a few foreign officers who received their military training in Europe. During his frequent visits to Western Europe, Peter the Great never failed to study the "up-to-date" organization and equipment of the best armies, and to introduce some into his own army. He always profited from the bitter lessons of his many defeats, and constantly perfected his army until finally he completely defeated his principal teacher on the battlefields, the military genius of that age, the Swedish king, Charles the Twelfth.

The creative mind of Peter the Great was not lulled into inactivity by this tremendous victory over the best army of his time. While he had at his disposal an inexhaustible source of manpower in his people, he fully realized the importance of an adequate equipment for his army. Having founded the new capital of his empire, St. Petersburg, and desiring to attract to it as many residents as he could, he established several ordnance plants in St. Petersburg and in its suburbs. His successors continued this policy and founded more ordnance plants there. It is true, with the expansion of Russia under his successors, ordnance plants were founded in other localities; but until the beginning of the present century, the center of gravity of the ordnance establishments remained in Petrograd and its environs.

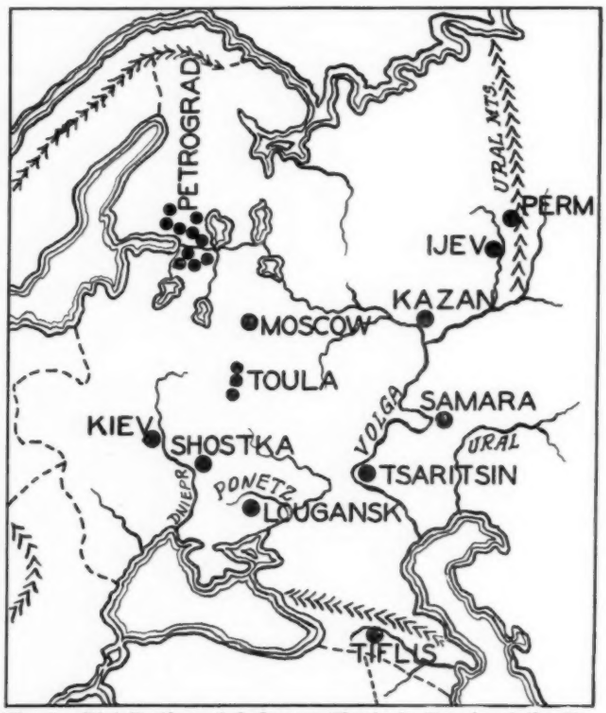

Fig. 1. Distribution of Ordnance Plants in Russia at the Beginning of the World War.

HOWEVER, the government of the last Czar realized the danger of the proximity of the ordnance plants to the frontier of the empire; and this conviction was strengthened by the events of the revolution of 1905 which demonstrated to the Russian Government the danger of concentrating large numbers of workers in the capital of the nation; as the "Soviet of Workers' and Soldiers' Deputies," the executive committee of the revolutionists of 1905, was largely composed of the workmen of the ordnance factories in and around Petrograd. What was foreseen by the founders of this country when they planned Washington, the capital of the United States, as a purely administrative center without industrial establishments, was not foreseen by Peter the Great when he was planning St. Petersburg, the new capital of Russia.

Although too late, the Imperial government of the last Czars accepted as a doctrine the policy of not loading Petrograd with new ordnance plants; these were built mainly in the Volga system, far from frontier and capital. The accompanying map (Fig. 1) shows the distribution of ordnance plants in Russia at the beginning of the World War.

In Petrograd and its suburbs there were: Petrograd Gun Works, Petrograd Small Arms Ammunition Plant, Poutilov Works (a semi-private organization manufacturing big guns), Obioukhov Gun Works, Okhta Powder Plant, Okhta High Explosives Plant, Sestroretzk Rifle Plant, the Main Proving Ground and the Ijora Admiralty Works.

West of the Volga River there were the Toula Rifle Plant, Toula Small Arms Ammunition plant (private), and the Lougansk Small Arms Ammunition Plant.

On the Volga System there were the Perm Gun Works, Ijev Rifle Plant, Kazan Powder Plant, Samara Fuze Plant, and the Tsaritsin Powder Plant.

With two indicated exceptions all the above plants belonged to the government; the Ijora Works was under the jurisdiction of the Russian Admiralty while the remaining plants were under the jurisdiction of, and were operated by, the Artillery branch of the Russian Army; as there never existed an independent Ordnance Department in Russia.

Besides the above named ordnance plants there were several "arsenals" in important military centers, such as Moscow, Kiev, Tiflis, etc. These so-called arsenals were, rather, very large repair plants than manufacturing plants, although they often manufactured gun carriages, ammunition wagons, ambulances, field kitchens, etc.

The other supply branches, such as the Quartermaster Department or, as it is called in Russia *Intendantstwo,*

Engineers, and Medical and Veterinary Departments did not have their own manufacturing establishments, and in time of peace or in time of war they relied upon private industry alone. Of course, as everywhere else, ordnance matériel being of noncommercial character, the ordnance plants in Russia belonged to the government.

FOR more than one thousand years Russia was an unlimited monarchy. The late Czar Nicholas ascended the ancestral throne as an autocrat, lived through two wars and

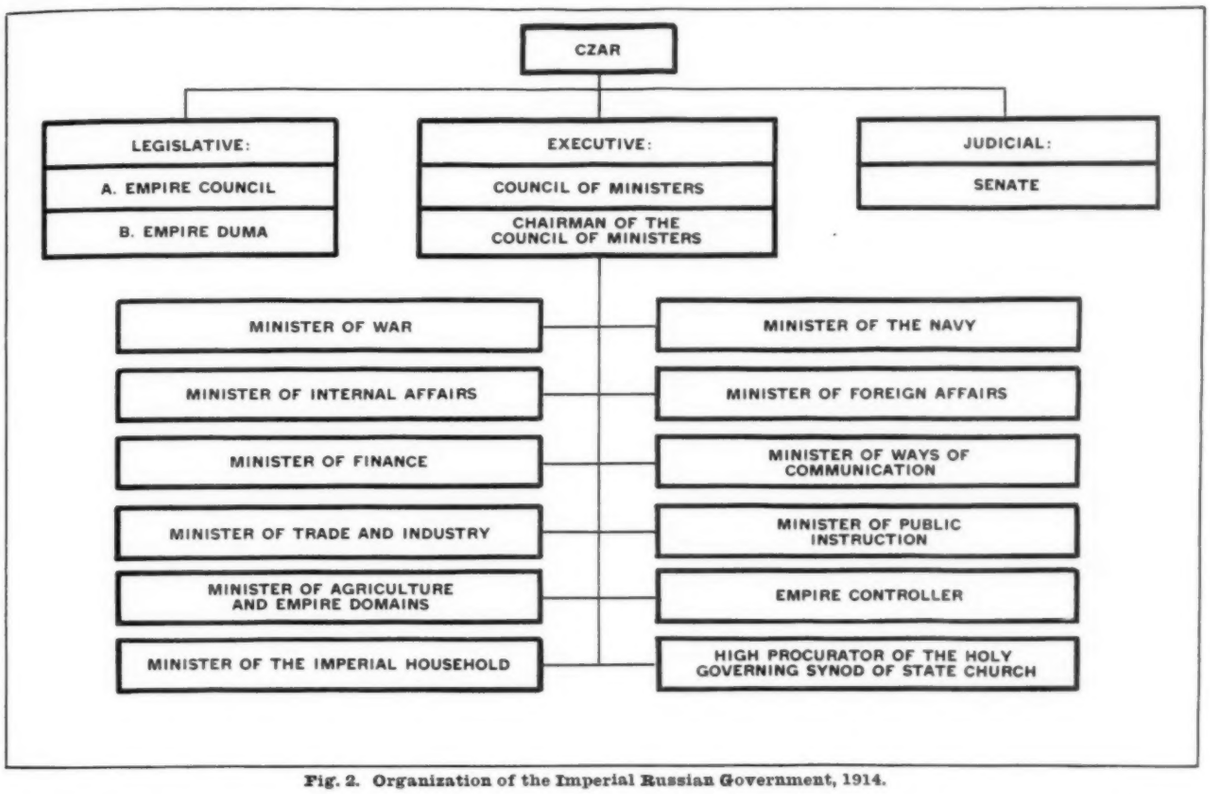

Fig. 2. Organization of the Imperial Russian Government, 1914.

two revolutions, and saw the utter collapse of his great empire, paying with his life and the lives of the whole royal family for mistakes of his father and himself. From the time of Peter the Great there have been many experiments to modernize the political system in Russia, both from above and from below, as well by evolution as by revolution. As a result of these experiments the organization of the Russian Government at the beginning of the World War in 1914 was as schematically shown in Fig. 2.

The supreme power belonged to the Czar "by the grace of God"; under him there were the usual three branches of government; namely the legislative, the judicial and the executive.

The legislative branch consisted of an upper house, the Empire Council, a semi-elective and semi-appointed body, and a lower house, the Empire Duma, the members of which were elected through a very complicated electoral system. The legislative power was limited by the unconditional veto power of the Czar.

The judicial branch, the Senate, had its members appointed by the Czar; although being the Supreme Court of the Empire, it had not power of interpreting the constitutional laws, the weakest part of the government, it was not affected by the current political tendencies and therefore enjoyed the full confidence of the population.

The executive branch, the Council of Ministers, consisted of nine ministers, the heads of the usual government departments, and the Empire Controller whose membership in the Council was well justified. Besides these, there were two other members of the Council: the Minister of Imperial Household, a very influential figure in Russian politics, and the High Procurator of the Governing Synod of the State Orthodox Catholic Church (Roman Catholics, all Protestant denominations, Jews, Mohammedans and others, were under the supervision of the Ministry of Internal Affairs). The Chairman of the Council of Ministers, the Prime Minister, usually held the portfolio of Internal Affairs in addition to his premiership, and he was the most influential figure in Russian political life.

All ministers were responsible to the Czar alone. The Empire Duma, in its efforts to introduce parlamentarian government into Russia, always insisted that the Cabinet be responsible to that legislative body; the Czar always refused to consent to this, desiring to retain an absolute control over the executive branch of the government. Had he consented to grant this request the history of many nations would be quite different.

NOT having overseas colonies Russia always was a land power and her strength was in her land forces. Her fleet was primarily for defense while she employed her armies both in the defensive and the offensive wars. Therefore it is quite natural that the Ministry of War was her most important agency of war preparedness. In Fig. 3 is shown schematically the organization of the Ministry of War.

The administration of Russia's land forces was in charge

of the Minister of War. As the training of the Czars-to-be was mostly of military character, the Czars were always interested in military matters and therefore they took an active part in directing military affairs. The Minister of War was rather a secretary of war than a responsible head of an important department of the empire government, while, for instance, a Minister of Finance, an expert in the intricacies of laws of demand and supply, almost invariably exercised his functions independently, as his sovereigns were not masters of this art.

The other male members of the imperial family also were trained in military schools and served as officers in the army and navy. Their high standing insured them rapid advancement in rank and high position in service. Usually they were good and efficient officers fully deserving their high positions. Sufficient to remember that idol of soldiers Grand Duke Nicholas, the Commander-in-Chief of Russian Armies during the first part of the World War, and the Grand Duke Constantine, the chief of the Department of Military Schools, an outstanding educator, himself a poet and a writer of great repute.

But there was a serious drawback in the service of the members of the royal family in the army and navy. Their high standing and close proximity to the throne sometimes, in spite of the best intentions on their part, carried with it a lack of real responsibility, rendering the nominal chiefs of services figureheads only, quite powerless to perform their statutary duties unhampered by high influence. Later we shall see an impossible resultant situation in the Artillery (Ordnance) Department just before the war.

IN performance of his duties the Minister of War was assisted by the War Council, an advisory body, consisting of members appointed by the Czar. On the one hand, this Council was composed of old generals who, although no longer in commanding positions, were very valuable because of their experience in military affairs. On the other hand, an appointment to the War Council sometimes was an ill-disguised retirement of a younger general who fell in disfavor with an influential power behind the veil. As a matter of fact, the War Council did not enjoy influence to any considerable extent. The Office of the Ministry of War was rather a misnomer to the Office of Minister of War, an executive office carrying out the general administrative functions.

There were two staffs in the Russian Army; the General Staff and the Main Staff. The General Staff did not have administrative functions; it was a war planning agency mostly concerned with strategical problems and preparations of plans for conducting war; it handled also the preparation of mobilization plans. The Main Staff was in charge of the current administration of the standing army, its transportation, dislocation and training of line troops. For military purposes Russia was divided into ten military areas each under its commanding general, the potential commander of the group of armies in case of war. All line troops within a given military area were under the command and jurisdiction of the commanding general of this military area. Otherwise self-governing Cossack troops were also under military command of the commanding generals of the military areas. The Minister of War supervised the training of line troops through four inspectors-general, those of infantry, cavalry, artillery, and engineers.

The Assistant Minister of War, while assisting the Minister of War in all his works, was concerned mainly with the supply departments of the army; artillery (ordnance) intendantstvo (quartermaster), engineers and medical (including veterinary) departments. Each of these departments exercised administrative functions in respect of military establishments under their jurisdiction, acted as procurement agencies supplying the needs of the army, and supervised the training of their military personnel.

The Artillery (Ordnance) Department was the most important of all supply branches. Victory or defeat depended largely upon the efficient conduct of the activities of this supply branch. Its personnel consisted of highly trained officers who, upon graduation from the seven years' course at the cadet corps military secondary school, entered for a three year course in the artillery tertiary school, from which they were graduated, with the rank of second lieutenant. They served with artillery line troops for at least three years and then, upon severe competitive examinations, entered the artillery college where they received both higher artillery and ordnance engineering training. Many of them became distinguished scientists and engineers of world repute.

The organization of the Artillery (Ordnance) Department is shown on Fig. 4.

The greatest handicap of this organization was its divided, or rather undertermined, responsibility. While a responsible head of his department on paper, the Chief of Ordnance was *de facto* nothing more than a figurehead, as Grand Duke Sergius, being an inspector-general of artillery, was the silent chief of this department. He had his private office in the Ordnance Department and not a single important decision was taken without his approval. To him reported not only the nominal chief of the department but also the chiefs of divisions and often even the section heads. As an inspector-general, the Grand Duke Sergius was very efficient, but as an administrator he was next to failure. The Minister of War and his assistant often reprimanded the nominal Chief of Ordnance; the Empire Duma was sharply against the Grand Duke's meddling in the administration of the Ordnance Department, loudly declaring that "it is impossible to appoint irresponsible persons to responsible positions"; but the nominal Chief of Ordnance was powerless to change the situation as the Grand Duke Sergius had the backing of the Czar. The result of this sad story was that nobody was responsible for adequate ordnance war reserves.

As a matter of fact the lower house, the Duma, was always favorable to the credits for the national defense. Soon after the Russian-Japanese War, in 1908, the Duma created within itself a commission on military affairs which passed on all appropriation bills for national defense. The Duma never refused in approving them.

THE war plans prepared by the Russian General Staff were based primarily upon the experience of the Russian-Japanese War, 1904-1905. Together with military leaders of other European nations the Russian generals were under the conviction that a major war could not last longer than from three to six months. Together with other European nations, Russia was endeavoring to accumulate war reserves sufficient for a short, intensive campaign. Everybody

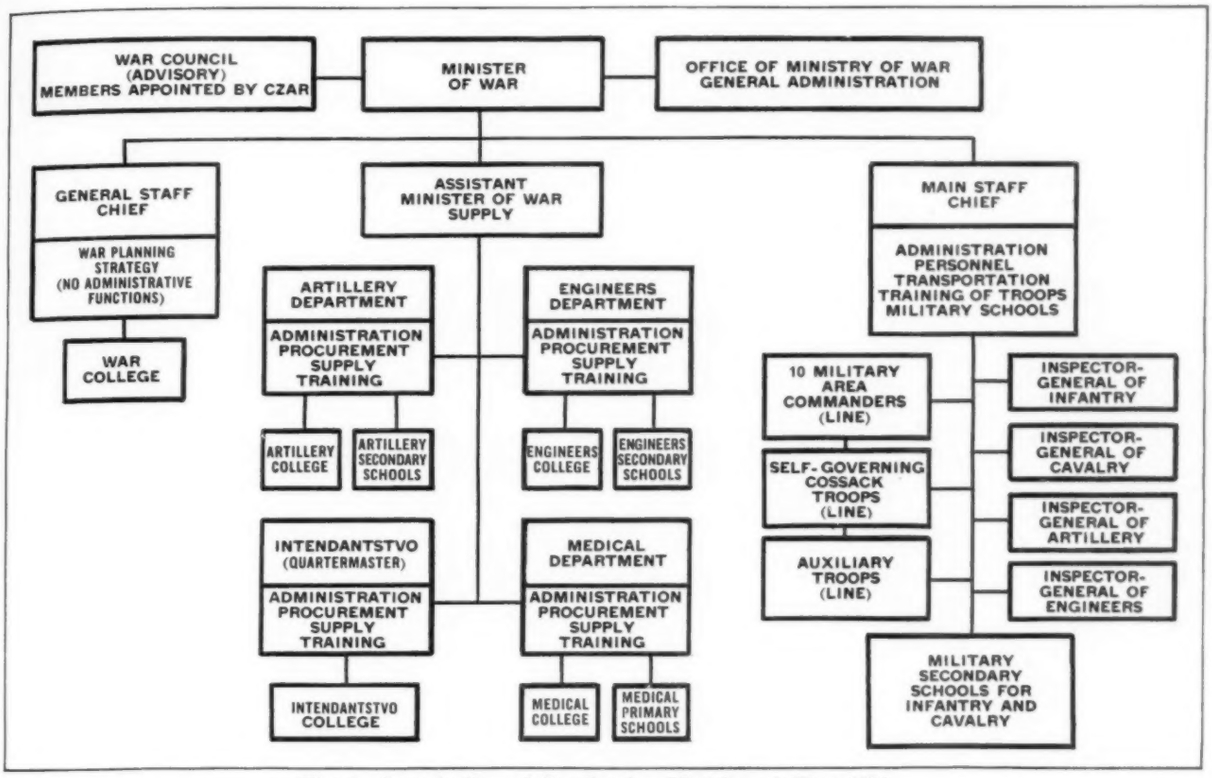

Fig. 3. Organization of the Russian Ministry of War, 1914.

thought that the civilian industry would not be called to produce war matériel as a short war would depend on accumulated war reserves, and the war would have ended before civilian industry would have time to produce the first lots of ammunition.

The Russian General Staff set, as the norm of war reserve, 1000 shells per gun; however, as other main continental powers had set their norms at from 2000 to 3000 shells per gun, the Russian General Staff became alarmed and requested a revision of the Russian norm, increasing it at least to 2000 or 3000 shells per gun. During the discussions it was discovered that, due to the resistance of the Ordnance Department, actual war reserves amounted to 500 shells per gun only. The Ordnance Department and Grand Duke Sergius insisted that there was no necessity for raising the norm as the actual average expenditure of shells during the Russian-Japanese War did not exceed 500 shells per gun. After much dickering, the Minister of War approved a norm of 1500 shells per gun. In 1913 the Duma passed credits providing this norm; orders were issued to the Ordnance Department to increase war reserves, but it was too late, and Russia entered into the war with 850 shells per gun only.

WHEN general mobilization was ordered in July 1914, the Minister of War issued orders to all supply branches to increase production in government plants up to their capacity and immediately to place necessary orders with civilian industry. But as nothing had been done toward planning for industrial mobilization, industry was not able to respond to the heavy demand. At the end of September 1914 first reports were received from the front calling attention to the scarcity of ammunition; in October similar complaints began to pour in with demands for more rifles, small arms ammunition, and signal equipment. In response to these complaints a series of conferences was held with the representatives of the supply branches. During these conferences the representatives of the Ordnance Department were more than lukewarm regarding increase in ammunition orders. Finally, in November it was decided to increase production of 3-inch shells up to 300,000 a month. Representatives of the large civilian plants were called in and the above mentioned monthly production was distributed among them.

At the end of 1914 and beginning of 1915 the Commander-in-Chief, the Grand Duke Nicholas, sent several sharp telegrams to the Minister of War reproaching him for poor supply of ammunition and rifles. But the Artillery (Ordnance) Department continued to insist that 300,000 shells per month was quite sufficient. An exhaustive investigation of production of component parts of shells showed the real reason of such an attitude of the Ordnance Department: the maximum combined production of time fuzes was only 300,000 per month. As a result of this investigation manufacture of fuzes of simpler construction, of the French type, was ordered. At the same time large orders for fuzes and rifles were placed in the United States.

The Czar's ukase for general mobilization brought under the colors, 6,870,000 men during the first ten days of the war; later, for necessary replacements many more millions were mobilized. It is estimated that during the period from the beginning of the war until the collapse of the Russian Army at the beginning of the Bolshevik revolution in November 1917, the total number of mobilized men amounted to 17,600,000. Just make a mental picture of the result of the war had there been proper ordnance supply!

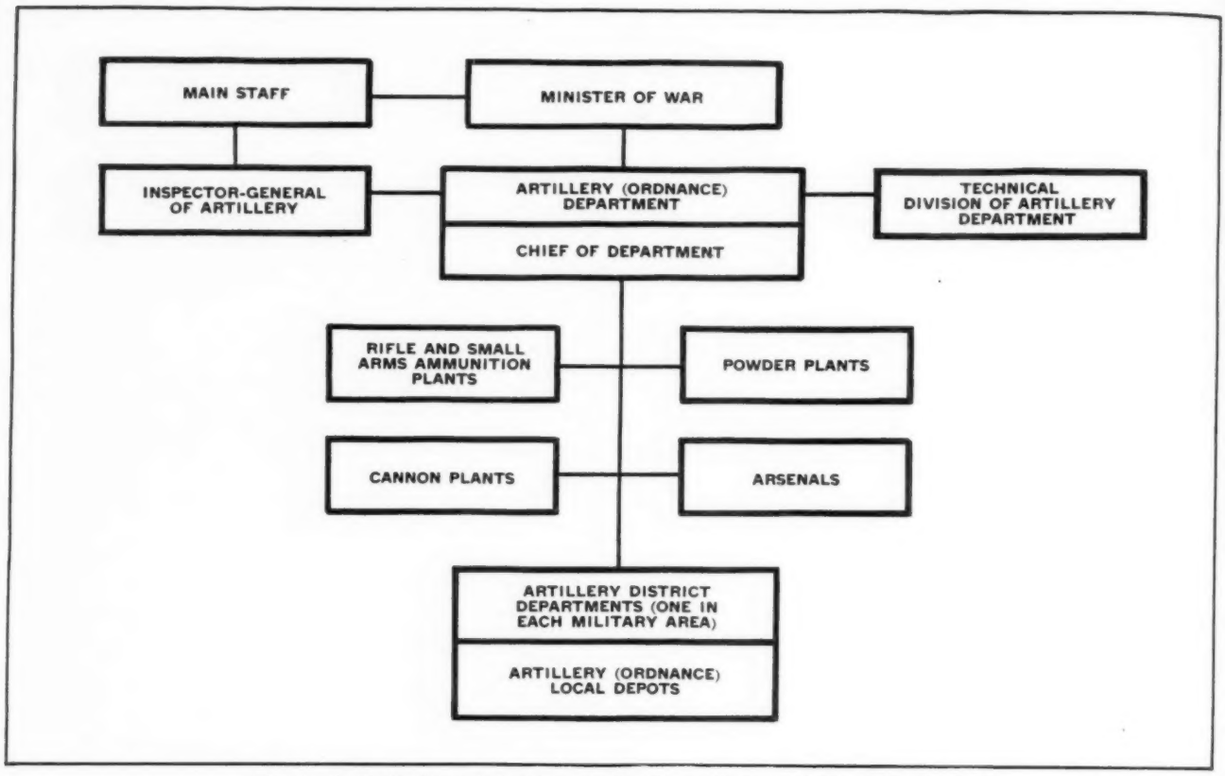

Fig. 4. Organization of the Russian Artillery (Ordnance) Department, 1914.

Although the Czar's signature was sufficient to mobilize millions of men, it was almost powerless to augment limited reserves of war material, and still less effective in creating new facilities for its production. Russia entered the war with enormous manpower but without means to supply her armies with necessary munitions. The main source of supply was in the government-owned and -operated ordnance plants as enumerated above. This source proved to be quite inadequate to produce munitions in required quantities. Nothing was done during peace time for planning the mobilization of private industry; as to actually mobilizing it in war time—that was an enormous task, next to the impossible.

RUSSIA, with the abolition of serfdom a few years before similar abolition of slavery in the United States, began to develop her industries, but this process was very slow; she was and still is an agricultural state. In 1912, two years before the war, there were in Russia 4,500,000 industrial workers, men and women, in all branches of industry, including transportation, mining and different handicrafts; her total population was 170,000,000 of which at least 85 per cent was rural; her main items of export were grain and raw materials. With the beginning of the World War new heavy demands were placed upon her industries and agriculture; it is estimated that from the beginning of mobilization every soldier consumed three times as much food, clothing, etc., as he consumed as a peasant in peace time. Add to this the demand for high quality war matériel, and it is no wonder that the weak Russian industry failed to meet this demand. The unpreparedness of the War Department in not planning mobilization of private industry lead to such a lack of matériel that the Commander-in-Chief, the Grand Duke Nicholas, was quite justified in using abusive language in his telegraphic requests addressed to the War Ministry.

WHEN war was declared, there was a general haphazard rush of the supply branches to place war orders; each supply branch made its own contracts with private industry without regard to the needs of other departments. The general picture was similar to that in the United States: buyer's competition with its resultant sky-soaring prices and attempts at profiteering. But here we had highly developed private industry while in Russia the available productive capacity was exhausted almost in no time, and, to satisfy the heavy demand of the combatant branches, it became necessary to go abroad with war orders. The conditions were aggravated very much by the unscrupulous promoters whose sole technical equipment consisted in capacious empty pocketbooks to be filled with advances from the government; as to the contracts—the promoters figured on selling them to the real manufacturers, pocketing the difference. In their attempts to make money, the profiteers used high influence, sometimes obtaining the Czar's direct orders. Of course the Czar, not being an engineer, merely issued orders to help "patriotic men and women" to help win the war; nevertheless the War Department often encountered much trouble in counteracting the machinations of influential parties of high social standing.

While the army was taken care of in the first place, the needs of the civilian population suffered to a great extent. To relieve the civilian population there was no agency, as all the government's efforts were directed toward satisfying the needs of the army. Then two new organizations appeared: "The All-Russian Union of Zemstvos" and "The

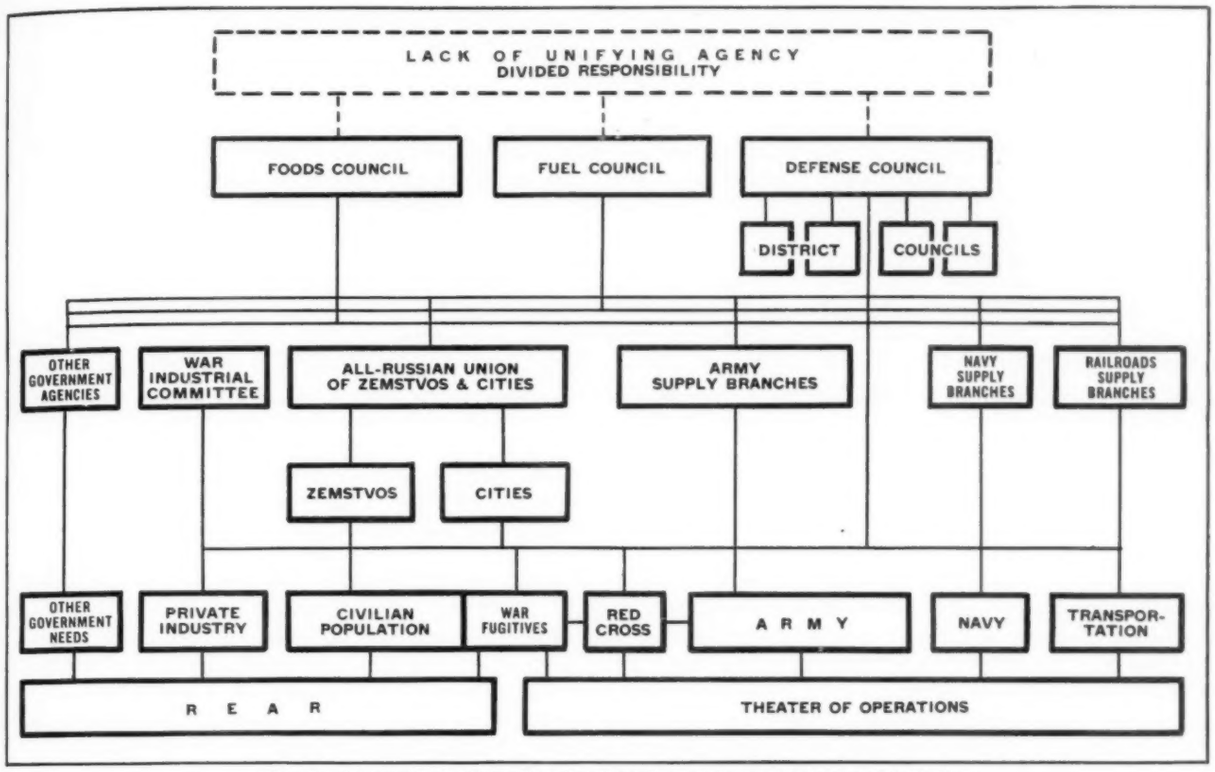

Fig. 5. Attempts to Organize the Russian Defense System, 1915-1916.

All-Russian Union of Cities," finally united in one "All-Russian Union of Zemstvos and Cities."

Contrary to the general belief abroad, there existed in Russia a highly developed local self-government. For administrative purposes Russia was divided into 78 provinces or *Goubernias,* and each of these was divided into several, usually 10 to 15 counties or *ouezd*. The governor of each *goubernia* was appointed by the Czar while the officials in the *ouezds* were appointed by the Ministry of Internal Affairs. But each *ouezd* had its self-government through its *Ouezd Zemskaya Duma* and each *goubernia* had its *Goubernia Zemskaya Duma,* representative bodies of local self-government. The cities were under separate self-government through their individual city councils or *gorodskaya Dumas.* These self-governing bodies, although under strict control of the central government, took care of the cultural necessities of the population: primary schools, hospitals, public health, roads, water and gas works, electric power plants, agricultural experimental stations, etc.

WHEN the war came all cultural work carried on by the *zemstvos* and cities was upset. Heavy burdens imposed upon them by quartering troops, acceptance, distributon and taking care of wounded and sick, and other war work, interferred seriously with their regular activities.

With private industry almost exclusively working for the armies, the zemstvos and cities found themselves at a disadvantage. Realizing that "strength is in unity" they combined themselves, with the sanction of the central government, into the "All-Russian Union of Zemstvos and Cities," and became a powerful factor not only on the national but also the international market, spending millions of roubles buying necessary goods for the noncombatant population.

Parallel with the above mentioned union, another organization appeared in the field of Russian industrial life; the leaders of industry formed "The War Industrial Committee" with the hope of bringing order from chaos. This organization, although less powerful than the Union of Zemstvos and Cities, exercised great influence on the commercial and industrial activities of Russia. But still it increased the chaos.

The course of events showed clearly that to eliminate chaos industry must be mobilized in an orderly manner. At the time when the shortage of war material forced the Russian Army to evacuate Poland to shorten and strengthen the fire line came the test. The evacuation was executed in a wonderfully ordered manner although under constant fighting day and night. Russians could not answer the German artillery fire because of an almost complete lack of ammunition. There was an order issued at that time forbidding battery commanders to shoot more than five shells without specific permission from the army corps commander; every shell at the battery was known by its first, middle, and last name. Russian artillerymen were sometimes insane with this order of things; they did their best under the circumstances and the shortage of ammunition was supplanted by skill: almost every shell hit its mark.

IN the second half of 1915, the Empire Defense Council was organized. It was composed, under the chairmanship of the Minister of War, of ministers of the Navy, Finance, Internal Affairs, Agriculture, Trade and Industry, Ways of Communications, Presidents of the Empire Council and Empire Duma (9 members of each of these two legislative bodies), representatives of All-Russian Union of *Zemstvos* and Cities, and representatives of the War In-

dustrial Committee. The Empire Defense Council formed several district defense councils in the more important industrial centers; Petrograd, Moscow, Kiev, Ekaterinoslov, etc. The district defense councils were organized under the chairmanship of a general, usually a commanding officer of the nearest ordnance plant, of local representatives of the zemstvos and cities, the war industrial committee, local high officials of different ministeries, representatives of all supply branches and representatives at large of the army and navy.

Theoretically, the Empire Defense Council had full power in directing Russian industry in its work of supplying the army with war matériel. But from the very beginning the defense council became an arena for conflicting interests; decisions on the most important questions were made under high pressure from interested members of the council as well as from powerful interests behind the curtain. No doubt, there were fervent patriots among the business men and their assistants, senior engineers, who understood well the needs of the country and whose souls grieved over the existing chaotic conditions, but they did not exercise sufficient influence over the course of events. It is quite evident that it was impossible to make decisions on complicated technical questions in a gathering of fifty to sixty council members, the great majority of whom did not know the intricacies of the technical side of the questions. Accordingly there were formed numerous "preparatory," "control," "supervising" etc. commissions, the work of which consisted mainly in endless deliberation instead of action.

To make things worse, two more councils were created: the Foods Council and the Fuel Council, and all these councils were independent: there was no unifying agency, no master mind, to coördinate their work. The final outcome was inevitable; the collapse of the Russian Army, revolution, downfall of the dynasty and the bolshevist régime and communism.

The Russian Army was not defeated on the field of honor; it was brought to an inevitable collapse by the inefficiency of the rear, by mismanagement of industry, and by the lack of statesmanship which did not foresee the necessity of industrial preparedness and the planning of industrial mobilization.

IT is interesting to note that neither the Allies nor the Central Powers showed any great efficiency in conducting the World War. A few interesting figures may well illustrate the efficiency, or rather inefficiency, of both sides. Taking an approximate cost of war to all nations involved in the great struggle as equal to 180 billion dollars and the loss in killed to eight million men, we find that the cost of killing one man was about 22,000 dollars. The war had cost the Allies 123 billion dollars and a loss of 5,172,000 men; the war had cost the Central powers 57 billion dollars and a loss of 2,815,000 men. To kill one German soldier cost the Allies about 44,000 dollars while to kill one Allies' soldier cost Germany about 11,000 dollars. These figures show clearly that the killing efficiency of the Central Powers was about four times better than that of the Allies.

Four thousand years ago it was considered that 200,000 slaves building a pyramid during the span of human life was a very efficient way to achieve results. At the present time any American building concern would undertake building another huge pyramid inside of five years employing not more than 3,000 workmen, because it would replace manpower by the horsepower of modern machinery used in a prearranged orderly manner; and while almost all of the 200,000 slaves of the ancient pyramid builder perished as a result of the construction work, our American builder would bring back almost all of the 3,000 modern workmen; the loss would be confined to wear and tear of lifeless machinery. The history of the construction of the Panama Canal is in point. And the lesson of it all is this: while not denying that infantry will remain the queen of the battlefield in the wars to come, we could secure victory with less loss by drafting replaceable kilowatt- and horsepower instead of precious manpower. We have only to foresee and prepare plans for mobilization of industry.

The "Czar-Pushka," in the Kremlin at Moscow.

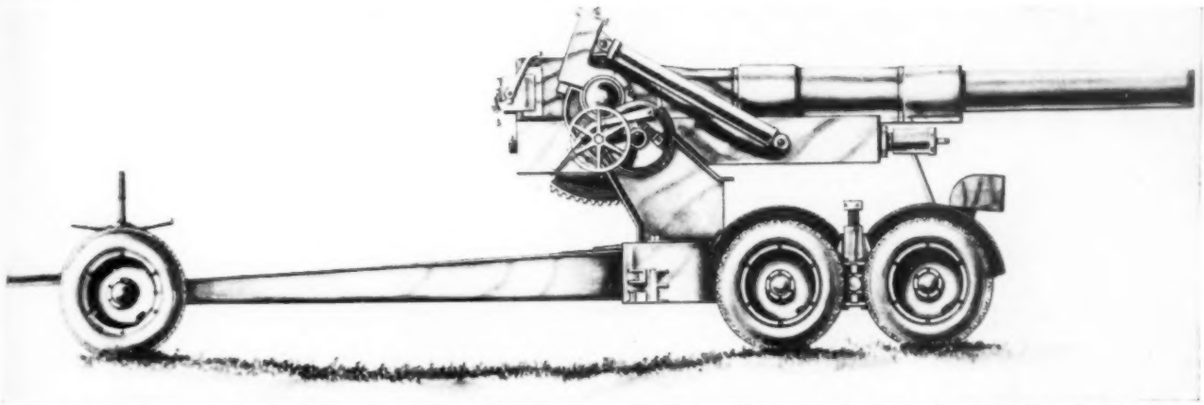

Fig. 1. Drawing of the New 155-mm. Gun, 8-inch Howitzer Carriage, Model T2, showing the Howitzer Mounted in Traveling Position.

American Heavy Artillery, Model 1931

Post-War Evolution of the Gun-Howitzer Carriage

By Elmer C. Goebert*

IN the World War the United States Army employed two models of the 155-mm. gun and two models of the 8-inch howitzer. The 155-mm. gun, model 1917, was the French Grande Puissance Filloux; the model 1918 was an American adaption of the French design. The 8-inch howitzer, model 1917, was the English Vickers howitzer; the model 1918 was an American adaption of the English design.

The following table gives the principal characteristics of these weapons:

	155-mm. Gun, M 1917	155-mm. Gun M 1918	8-inch Howitzer, M 1917	8-inch Howitzer, M 1918
Weight of projectile (lbs.)	95	95	200	200
Maximum range (yds.)	17460	17460	10500	13003
Maximum elevation (deg.)	35	35	50	45
Total traverse (degrees)	60	60	8	8
Weight of cannon and breech (lbs.)	8520	8715	6555	7500
Weight of cannon mounted on carriage in firing position (lbs.)	23660	25960	19100	20048
Weight of weapon in traveling position, single load (lbs.)	28840	29410	29540	30490

The 155-mm. gun Model 1917 as illustrated in Figs. 2 and 3 clearly indicates the general design of the weapon. The model of 1918 was identical with the model 1917 except in certain minor points of design. The same is true when a comparison is made between the two 8-inch howitzer models so that it suffices to show but one of these weapons. Fig. 4 shows the 8-inch howitzer, model 1917.

Fig. 2. The 155-mm. Gun. (G. P. F.), Model 1917.

Both the 155-mm. guns and the 8-inch howitzers were classed as army artillery and held their place as such in the World War. They exemplified heavy loads in traveling and their mobility was seriously impaired since the wheel bearings and suspensions of the carriages were designed for use as horse-drawn or slow, artillery tractor draft vehicles. The mobility, had it been possible to apply high-speed draft to these weapons, still would have been impaired since the load in transportation was poorly distributed and required that careful study of bridge capacities be made wherever stream crossings had to be negotiated. As a result, in some cases, long detours were necessary to place the weapons where they were desired.

THE Westervelt, or Caliber, Board in its report which was submitted May 23, 1919, recommended increases in range, traverse and elevations for the army artillery which, when comparison was made with the 155-mm. guns and 8-inch howitzers of the World War, showed them to be so inferior in performance that they could only be classed, all factors considered, as fair corps artillery weapons.

The Ordnance Department, in the studies which were made following the Caliber Board recommendations, found that the forces on the carriage resulting from the ballistic requirements of the 155-mm. gun and the 8-inch howitzer as specified by that Board, were almost identical and proceeded with the development of a carriage to mount either the gun or the howitzer.

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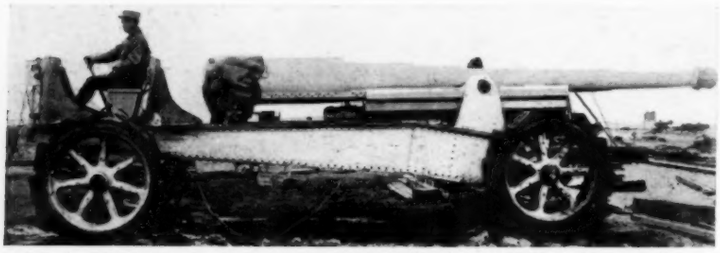


Fig. 3. The 155-mm. Gun (G. P. F.), Model 1917, in Traveling Position.

A new 155-mm. gun was designed which, with a 95-lb. projectile, had a maximum range of 26,000 yards. The weight of this gun was 9,200 lbs. A new 8-inch howitzer was designed at the same time and, with a 200-lb. projectile, had a maximum range of 18,000 yards and weighed 9,000 lbs.

The carriage designed to mount either of these two cannon was designated as the 155-mm. gun, 8-inch howitzer carriage, Model 1920 E, and is shown mounting the howitzer in Fig. 5 and mounting the gun in Fig. 6. For the sake of comparison between these two views the howitzer exclusive of the breech is 200 inches, or 16 feet 8 inches long, while the gun, exclusive of breech, is 274.7 inches, or 22 feet, 10.7 inches, long.

The following are the general characteristics of the carriage and recoil mechanism: maximum elevation, 65°; total traverse, 60°; spring suspended and hard rubber tired wheels; tread width, 88.5 inches; weight exclusive of cannon and breech, 18,800 lbs.; Filloux type variable recoil mechanism; maximum recoil, howitzer 71 inches, gun 60 inches; minimum recoil, howitzer 40 inches, gun 24 inches.

No attempt was made in this design to provide for greater traveling speed on the road since the possibility of application of high speed motive power to this type weapon had not as yet been realized, and it was intended that it would be drawn by the then existing slow speed artillery tractors.

The total weight of the carriage mounting the gun was 28,000 lbs. and again, as in the World War types, the bulk of the load was concentrated over one axle, as an examination of Fig. 6 will show, and the difficulties experienced on stream crossings had not been eliminated. It was therefore proposed to remove the gun and breech mechanism from the carriage and carry it as a separate load for long road hauls involving stream crossings.

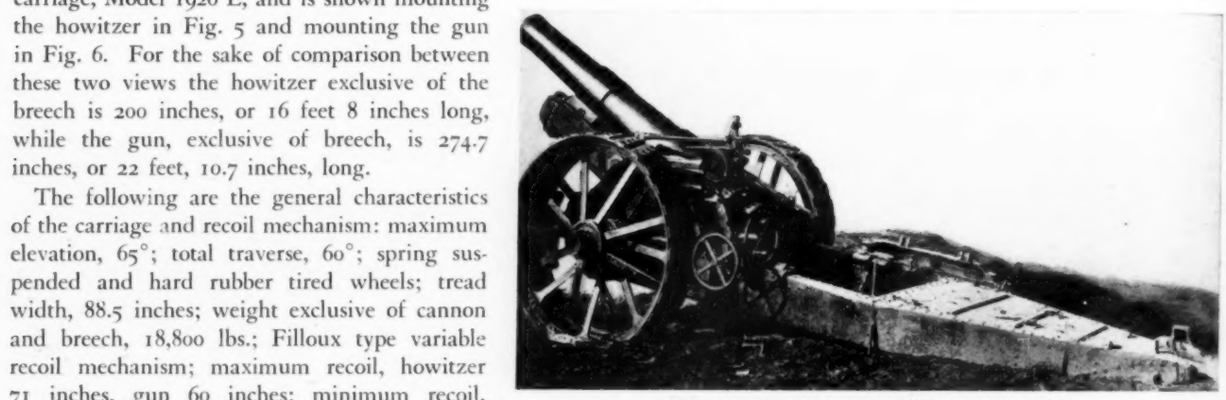


Fig. 4. The 8-inch Howitzer, Model 1917.

THE heavy transport wagon, model 1920, shown in Fig. 7 was designed to carry either the gun or howitzer. The tests of this accessory showed that while the purpose for which it was designed had been accomplished, its use in the field under service conditions was so unsatisfactory, due to difficulties of mounting and dismounting the gun, that it had to be discarded and an attempt made to obtain a more satisfactory solution.

The first result of this attempt is illustrated in Figs. 9, 10, 11, 12 and 13, which are pictures of a ½ scale wooden model built to demonstrate and study the principles involved in the design.

It was intended, as in the 1920 E model, that for transportation involving bridge crossings, the weapon be divided into two loads. Fig. 10 shows the carriage load while Fig. 11 illustrates the gun or howitzer load.

The total weight of the carriage mounting the howitzer in firing position, as illustrated in Fig. 9, was computed to be 27,500 lbs. To equalize the two loads in travel it was proposed to recoil the cylinders of the recuperator mechanism with the gun so that in splitting up the load for transportation they would become a part of the gun load. The recoil cylinder was placed below and the counter recoil cylinder above the gun.

The recoil and counter recoil rods were to be made fast to a bridge across the front of the cradle in such a manner that they could be readily released when the gun was removed from the carriage.

The gun proper provided the principal member for the transport wagon. It was held fast to the rear axle by a jack yoke over the gun and tie rods which fastened to lugs on the front recuperator mechanism yoke. The top of the breech was slotted to receive a tow bar which, when locked in place, provided the eye which rested over the horn on the front bogie.

Fig. 5. The 155-mm. Gun. 8-inch Howitzer Carriage, Model 1920 E, with the Howitzer Mounted.

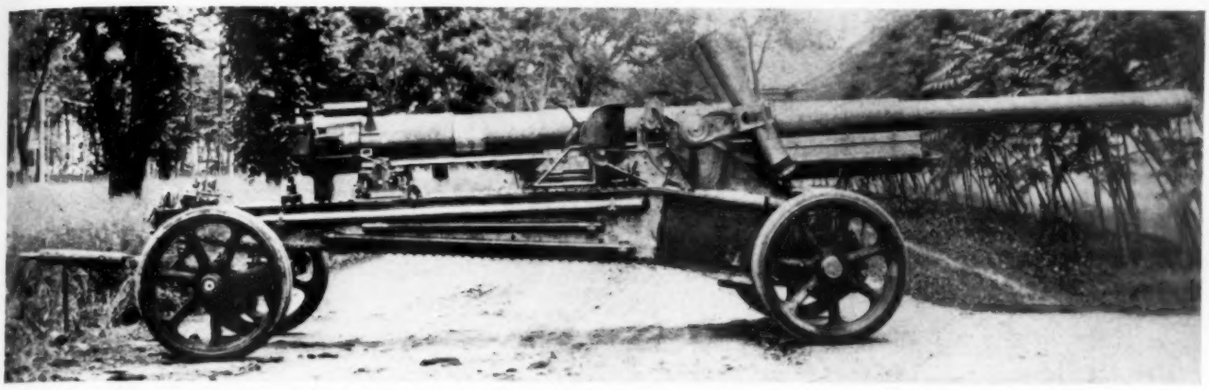


Fig. 6. The 155-mm. Gun, 8-inch Howitzer Carriage, Model 1920 E, with the Gun on Carriage, in Traveling Position.

The design as a whole included many ingenious features and the proposed method of mounting and dismounting the gun was extremely novel. These features can best be brought out by a description of the procedure in removing the gun from the carriage.

Referring to Fig. 10, it will be seen that the rear of the trails was provided with two run rails. To dismount the gun the trails were closed and locked. The upper half of the jack yoke on the rear bogie was then removed from the jack screws by means of the two ratchet wrenches provided on the equipment. The rear bogie of the transport wagon was then rolled up on the rails and forward until it dropped down between the end of the rails and the rear of the cradle of the carriage and then forward under the cradle until it was up against the traveling lock seen under the cradle.

Two hand bogies, illustrated at A, Fig. 12, were next placed on the trails forward of the front end of the rails. The front bogie of the transport wagon was rolled into position at the end of the trails. The tow bar A (Fig. 11) was then locked in place on top of the breech and a cable hook which ran to the tractor made fast to the eye B (Fig. 11). The carriage was set at approximately zero elevation and the recoil and counter recoil rods released at their forward ends.

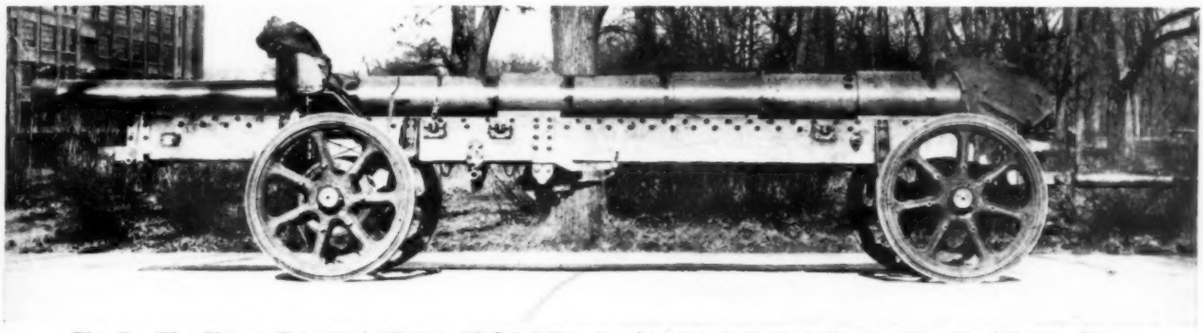


Fig. 7. The Heavy Transport Wagon, Model 1920, showing the Method of Transporting the 155-mm. Gun.

With this preparation the gun was ready to be pulled from the carriage. As it moved to the rear two men, one on either side of the trails, picked up one of the hand bogies, engaged it in a slot provided under the rear recuperator mechanism yoke and guided the flange wheels onto the rails. Another pair of men placed the other hand bogie in the slot under the front recuperator yoke and guided this bogie onto the rails. When the eye at the end of the tow bar was far enough to the rear the front transport bogie was

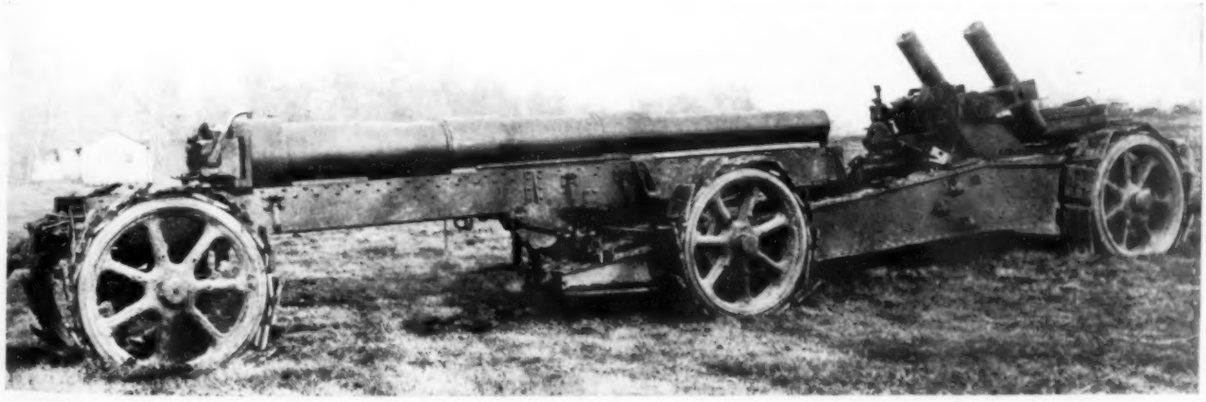


Fig. 8. The Heavy Transport Wagon, Model 1920, in Place for Mounting the 8-inch Howitzer on the Carriage.

maneuvered to engage the horn (C Fig. 11) in the eye. The movement to the rear was halted when a locating band marked on the gun came opposite the space between the rear end of the cradle and the front end of the rails.

The rear bogie was next rolled out from under the cradle, the upper saddle of the jack yoke placed over the gun and the rear transport bogie jacked up off the ground and tight against the gun. The tie rods were then made fast.

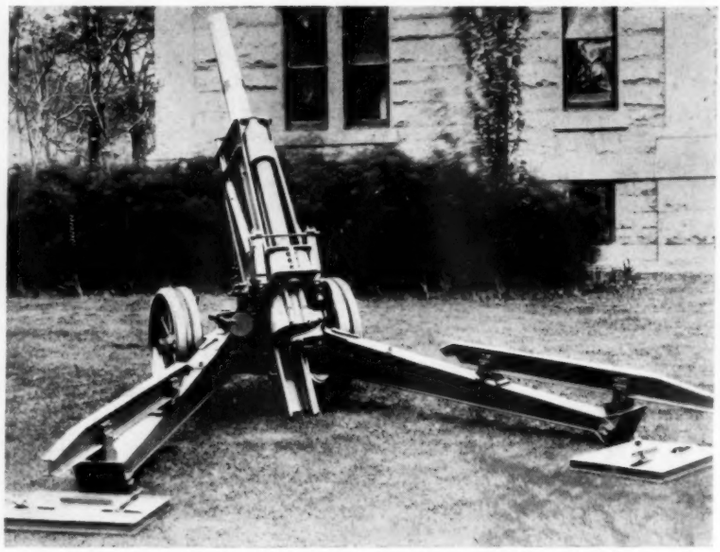


Fig. 9. The 155-mm. Gun, 8-inch Howitzer Carriage, Model T1, The Howitzer Mounted and in Firing Position.

The pull of the gun to the rear was then continued and in turn the hand bogies dropped from under the load and the rear transport bogies rolled down the ramps on the rear of the rails onto the ground.

While, as previously stated, the scheme was ingenious a careful consideration of the above description and a study of the model lead to the belief that while it was possible to handle the model easily on level ground the problem would be somewhat different and extremely difficult when handling the 11,000-lb. gun and recuperator mechanism out on the field where unevenness of ground had to be contended with, which would distort the alignment of the rails and other elements of the structure and introduce probably many pitfalls.

The above description brings the development of these items of ordnance in point of time up to the summer of 1929.

BEFORE continuing from this point it is desired to list some of the apparent disadvantages in the matériel which had been designed up to this time.

1. It was necessary to subdivide a 14-ton load into two loads for transportation which meant handling a weight ranging from 9,000 to 11,000 lbs. in the field.

2. Crane or portable jack equipment of some form had to be provided to limber the carriage.

3. The weight of the spades, which averaged from 500 to 600 lbs. each, made it almost essential to handle them by crane or similar equipment.

4. The wheel bearings had been designed for low speed transportation due to the use of slow tractors as motive power.

5. Twenty tons of material were required, exclusive of motive power, to make possible the transportation of a weapon whose ballistic characteristics required but 12 to 13 tons for stability if properly applied.

6. When traveling short distances over fairly good roads the gun had to be retracted to release the excessive concentrated load on one axle.

7. The limited resilience found in the solid rubber tires and the springs possible to apply in the type construction used resulted in road shocks being carried into the upper structure which subjected the carriage to unnecessary wear and tear in travel.

With the development of engineering practices as we see them commercially applied today it was believed that it should be possible to eliminate all of these objectionable features and to produce a simple design of carriage which would be comparatively easy to handle under the conditions met with in the field.

IN the early fall of 1929 studies of a carriage, to be known as the 155-mm. gun, 8-inch howitzer carriage, T2, were begun and the result of these studies is illustrated in Fig. 1. The carriage is at present under construction and it is hoped will be completed by the end of the present calendar year.

It is just one more advance in applying modern engineering knowledge to an old problem. So that the reader may

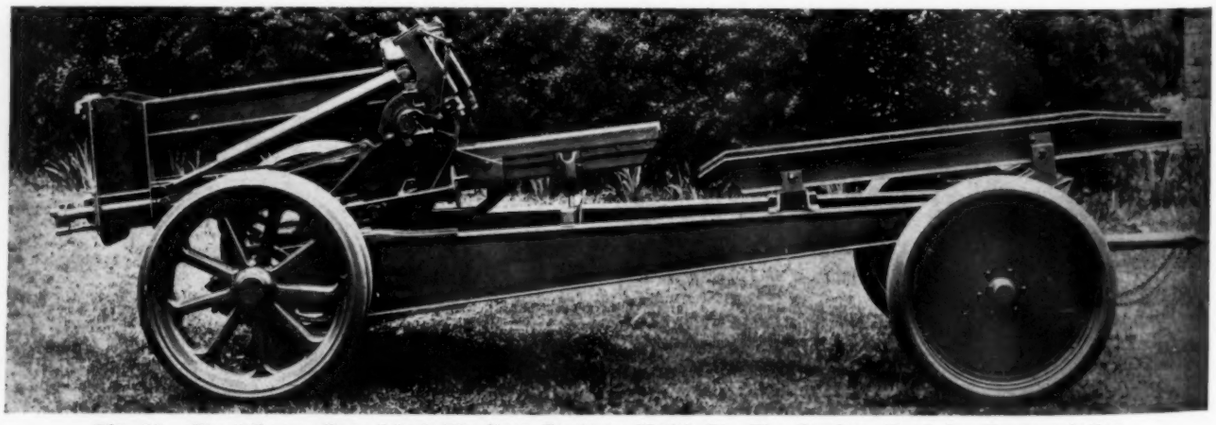


Fig. 10. The 155-mm. Gun, 8-inch Howitzer Carriage, Model T1—The Carriage Load for Transportation.

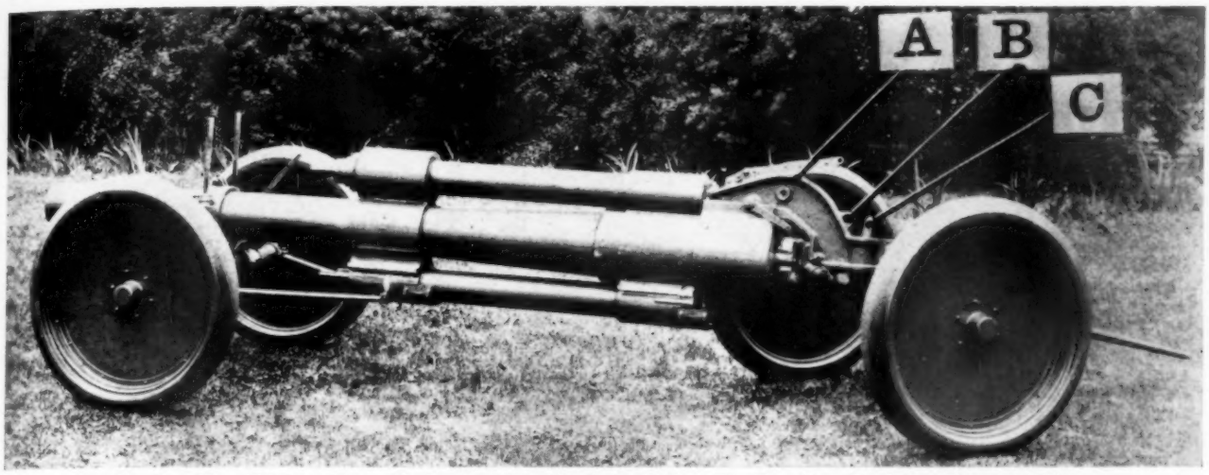


Fig. 11. The 155-mm. Gun, 8-inch Howitzer Carriage, Model T1—The Gun Load for Transportation.

appreciate how far it has been possible to apply sound engineering principles in the elimination of the seven objections stated above a brief outline of its characteristics will be given.

When completed, including spades, traveling lock and accessories, the carriage has been computed to weigh approximately 26,500 lbs.

The load has been distributed so that 18,000 lbs. will be carried on the forward truck which has two axles placed approximately 48 inches apart. The balance of the load, 8,500 lbs., which includes the weight of the trail bogie, will be carried on the single axle at the end of the trails.

The forward truck has the flexible mounting so successfully used by some of the leading commercial truck manufacturers and will carry eight pneumatic tires, each of which is capable of carrying a normal load of 4,000 lbs. with an overload rating of 6,000 lbs. The tires are mounted on quickly demountable rims commonly used in commercial practice. The wheels are equipped with roller bearings with sufficient rating to permit road speeds as high as any commercial truck built today. The truck is further equipped with a commercial type of mechanical four-wheel brakes.

The trail bogie provides a 44° turning angle and carries two of the same size tires as the forward truck. Here again the wheels are roller bearing equipped. The spade action in firing position is obtained through the use of four spades, the sum total weight of which is 700 lbs., the heaviest weighing less than 200 lbs.

In firing position the bottom carriage rests upon the ground. The carriage is lowered to the ground by built-in jacks which are a part of the truck and bogie. No crane is necessary to handle any part of the carriage—even the trails are picked up from the ground into a saddle and carried suspended under the axle instead of being picked up and placed over the axle as has been the practice in the past.

When in firing position but 2,000 lbs. (the weight of the trail bogie) will be removed so that instead of discarding approximately 30 per cent of the travel weight only 8 per cent will be removed since the four-wheeled truck remains as part of the stabilizing load in firing position. The weapon will have an elevation of from 0° to 65° and 60° traverse, no recoil pit being required.

The first carriage built from this design will mount the 8-inch howitzer since it is desired to test the design under the most severe load.

As can be appreciated by those experienced and familiar with the use and handling of heavy mobile artillery the results obtained with this carriage are being awaited with keen interest. If they approximate what is anticipated the effect of this type design will be far reaching and of the greatest tactical importance in the entire field of mobile artillery.

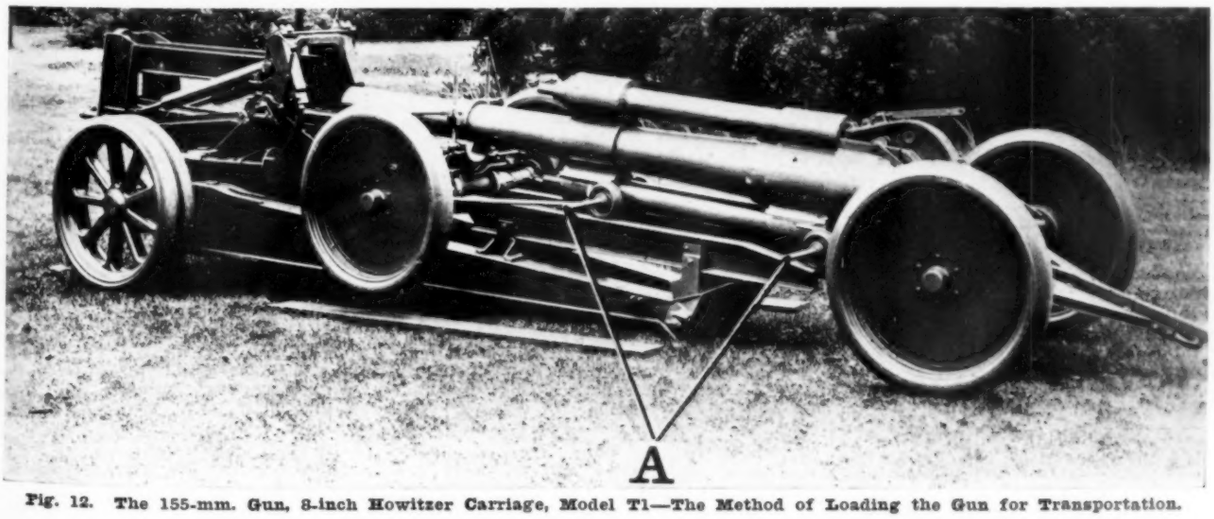


Fig. 12. The 155-mm. Gun, 8-inch Howitzer Carriage, Model T1—The Method of Loading the Gun for Transportation.

The Mechanization of War

Is It Necessary? Will It Last? What Will It Lead To?

By Maj. Gen. J. F. C. Fuller,* C.B., C.B.E., D.S.O.

PART II. 5. *Influences of Mechanization on the Restriction of War*

ACCEPTING as our premises the dual organization of fighting force, namely, mechanized troops and infantry, its obvious defect is at once apparent, namely, that in some wars mechanized troops will be of little use, whilst in others, infantry, as combatant troops, are likely to be an actual encumbrance. There is nothing new in this situation, for we have only to go back to the eighteenth century to find that the troops of the line were so unsuitable for mountain, forest and partisan warfare, that the declaration of each war was at once followed by the enlistment of large numbers of irregular troops—light infantry, light horse, sharpshooters, etc. Consequently, I am of opinion, that if small wars, which are really wars against nonindustrialized nations, are excluded, minor operations of war, such as clearing an enemy out of woods and broken ground unsuited to the movement of mechanized arms, need not perturb us. Throughout military history, no army has been prepared or organized in peace time to meet every type of war; instead armies have been, and are still, organized and equipped to meet only what they believe to be the most formidable type.

In the case of empires such as the British Empire and France we cannot, however, at present exclude the problem of small wars; but is not this problem excluding itself? For instance, if we examine the situation which today faces Great Britain on the north-west frontier of India, or France in Morocco, is it not rapidly being solved by the pressure of industrialization? The road, and not the bayonet, is silently and surely conquering savage lands. The road means trade, trade means civilization, and civilization means a restriction of the warlike spirit which is the offspring of uncivilized surroundings. Failing a world cataclysm, such as universal Bolshevism, one thing is certain, namely, that civilization will conquer uncivilized areas, not because this conquest is a military but an economic necessity.

The same compulsion of circumstances applies to all nonindustrialized countries, such as Afghanistan, Persia and China. The late King of Afghanistan having lost his throne through attempting to civilize his country, should not alarm us; for the mere fact that he made such an attempt, and not because it failed, shows that progress is percolating through the East. In China it is the same, for the revolt against Westernization is not a revolt against industrialization, but a revolt to remove it from Western exploitation. The coal-power of China is known to be enormous, and once law and order are established, and native resources developed, China will become industrialized, and in consequence her main fighting forces will in time become mechanized.

The same evolution applies to most other at present nonindustrialized nations; and such as cannot become industrialized, or are too small to develop sufficient wealth from their industries, and consequently too poor to afford mechanized armies will maintain their land forces on a militia footing, that is, purely for the maintenance of internal tranquillity, and whatever money the more virile of these nations can afford for frontier protection is likely to be spent on fortifications and aircraft. Aircraft, as they can avoid hostile armies and fleets, will prove a useful reinforcement for such of the greater powers who may come to their assistance. The same argument applies to small maritime nations and the submarine in naval defense.

Thus we see that the conclusion which we are faced by, namely, two forms of war—great and small—is likely to be a temporary one. That, in place, wars in barbarous regions and between the smaller civilized nations are likely to become less and less frequent, until finally they are altogether restricted, as piracy at sea has already been. This leaves us with one problem—the great war, and one military organization, namely, an army which can adequately take part in such a conflict.

Being left with this single war problem, I will examine it in some detail.

FIRST of all it must be accepted that a great war is only possible between two or more great nations; secondly, that as the whole world is economically becoming more and more interdependent, if wars are to continue it is to the advantage of every nation that their duration should be brief. Here we are presented with two important strategical factors; the one is that great military operations will take place in highly populated and developed areas, and that consequently great battles in mountainous and forest country are unlikely; the other is that neutral powers will from the very opening of hostilities bring pressure to bear to terminate the war, this pressure being expressed through public opinion and exercised through economic restrictions.

As regards the first of these two probabilities, it should be remembered that nearly all the great decisive battles of the past have been fought in open country, the reason being that in such areas communications abound, and the areas themselves being generally highly developed offer economic targets to the attacker. Mountain and forest warfare have always constituted subsidiary operations of an extremely difficult nature, because mountainous and wooded districts favor the defense. In the future, the difficulties hitherto patent to these areas are likely to be greatly reduced, because mechanized armies will be able to avoid them, and by overrunning the rich plain lands, and by attacking industrial and political centers they will bring such pressure to bear, that the war is likely to be terminated before their garrisons can make their influence felt. It follows, therefore, that the nation which can put into the field, not necessarily the largest but the most powerful mechanized army,

*In command of 14th Infantry Brigade, 5th Division, British Army, Catterick Camp, England. Part I of this article appeared in the January-February, 1931, issue of this Journal. Part II concludes this important discussion.

and which can from the moment hostilities are declared maintain forward movement, need pay little attention to areas unsuited to mechanized arms which lie within the enemy's frontier.

If money were unlimited, then the greatest industrial nation, supposing it to be imbued with a militarist spirit, would as far as land power is concerned have the world at its feet; for it must be realized that military movement will be so rapid that one or other of the belligerents will be overrun and disarmed before neutral powers can come to the support of either. If, in 1914, Germany had been able to overrun France in three weeks, the neutral world and the allies of France could have brought little pressure to bear upon Germany.

Money, however, is never unlimited, consequently we must now consider the financial factor.

Mechanization, in my opinion, will eventually prove extremely costly, possibly as costly as the mechanization of naval power has proved. Today it may be possible to produce an efficient light tank for £5000, but when international competition in tanks begins, improvement will follow improvement, and the price of machines will consequently soar. No nation is likely to be in the position to build and maintain more than a comparatively small mechanized army, for improvements in construction will be so rapid that each new batch of machines produced will be, as is the case in naval construction, in some respects obsolete the moment the machines are "launched." Further still, the cost of fighting machines will be only one item in the general cost. At sea, the British navy would be next to useless if it were not that it is based on an eleborate network of coaling stations, oil depots, defended harbors and coastal fortresses. The same will have to be constructed on land for mechanized armies, and as they cannot be built in potential enemy countries, they will be dotted here and there within the national frontiers, forming pivots of maneuver and protected centers for refuelling which will prove of enormous value in war.

From these considerations the following deductions may be made: The tendency in military evolution towards increased mobility, which is becoming paramount, will find its reaction in attempts to defeat this mobility by means of permanent and field fortifications. This reaction logically follows the constant tactical factor, for protective defensive power is the answer to protected offensive power. Whilst armored cross-country machines aim at developing mobility through armor, antitank defenses will strive to destroy the protection armor affords by gun fire, and simultaneously provide a defensive strategical area which will constitute a powerful base of operations for friendly mechanized forces. The cost of the defense will react on the cost of the offence; consequently mechanized armies will be comparatively small, and the smaller they are the more valuable will they become. Normally they will not seek battle in a hostile defended area, rather they will attempt to entice their enemy's mechanized troops into their own defended area. In any case they will not attempt to rush a defended area, the fortifications of which will probably consist of a large number of Martello towers, or small antitank works sunk in uncrossable moats and protected by fields of land mines. These works, like medieval castles, will protect all the main avenues of approach, and will link up topographical obstacles, such as mountains, rivers and woods, supplemented by plantations and inundations.

If these general deductions are in any way correct, then it will be seen that besides mechanized forces, large numbers of garrison troops will be required to man the defended areas, to occupy the hostile ones once they have been overrun, and to assist in their reduction. Thus, from a single conception of military force, which we arrived at on account of the probable disappearance of small wars and the unprofitable nature of mountain warfare, we have returned to the dual conception, namely, a mechanized army supported by a second line army, composed not of infantry trained to attack, but of foot soldiers trained to defend—partly engineers and partly antitank gunners. Finally we come to this somewhat perplexing conclusion: As the defensive gains on the offensive, as it always has after some new offensive weapon has been invented, and eventually estops this weapon until a still more powerful one replaces it, military operations will become slower and slower, until battles between mechanized armies are likely to grow as static as they were between the enormous muscular armies of the World War.

6. *Influence of Mechanization on the Elimination of War*

SHOULD mobile armor be eventually checkmated by static armor, for this is the situation we have now arrived at, seeing that air power cannot be so checked, it would appear that a possible solution to the above stalemate is to be found in the airplane—preëminently a motorized arm.

This is the solution put forward by most Air Forces, not as the answer of a problematical difficulty which may face us fifty years hence, but of the actual difficulty which faces us today. Their opinion is as follows: All military power is finally dependent on the civil will. It is the nation and not its army which makes war, consequently as the movement of air forces cannot to any great extent be restricted by armies and navies, the civil population can now be directly attacked and terrorized into submission. This argument is based on the experiences of the World War, which showed the enormous power of aircraft to terrorize capital cities and to impede work in industrial areas.

It is true that, in the World War, terrorization of the civil will was possible, and that had the war continued the attack on the civil will might have proved fully effective; but, when this argument is put forward, it is frequently forgotten that its effectiveness mainly depended on the static nature of the war. Fronts being entrenched, the whole of the ground organization of the respective air forces behind the entrenched fronts was immune from all forms of attack except that by aircraft.

Now, if I am right in supposing that we are today entering a mobile period of war, then this static condition will no longer hold good. True, aircraft, when in the air, will be almost as little affected by mechanized armies as by existing ones, which closely resemble those of 1914-1918; but aircraft on the ground, and all that aircraft require—workshops, depots, manufactories, etc.,—will be at the mercy of hostile armored machines. Further still, unless these machines are halted, the civil will can be even more effectively attacked by tanks and armored cars than by airship and airplane. An unopposed mechanized army could easily overrun France or Germany in three or four days, and not

only terrorize the civil population but occupy their political and industrial centers, which is a far more effective way of enforcing peace than by pure terror and destruction. Obviously, therefore, they will be opposed, and as present-day armies will not be able to halt them, they will be opposed by their like, and this will mean that it is unlikely that any nation will be in a position to maintain so powerful an air force that it can afford to support its mechanized army and simultaneously launch hundreds of machines at its enemy's cities, for large numbers will be required if this form of attack is to take full and rapid effect. Just as the cost of the British navy limits the size of her army, so will the cost of continental armies seriously limit the size of their air forces in the future.

There is still another reason which supports this argument, and an equally potent one. Because the civil will can so easily be struck has already given rise to international legislation prohibiting such attacks. Though such restrictions of war are a frail protection, they undoubtedly do create a definite sentiment against air attacks, which at the opening of a great war, when neutral opinion is still in the balance, will have a marked influence on the behavior of the belligerents. So much so is this likely to be the case, that I much doubt whether, during the earlier period of another war, any nation will risk bombing its enemy's industrial centers and cities for fear of being branded an international criminal. We may conclude, therefore, that, because aircraft can attack the civil will, fear of such attacks will definitely restrict the outbreak of war; and because such attacks are contrary to international agreement, when war is declared, belligerents will hesitate to indulge in them until excuses can be found to justify them.

As a great war progresses, it is almost certain, seeing how interdependent the world is becoming economically, that one nation after another will be sucked into the vortex of war, as happened in the last war. Neutral opinion as the arbiter of the rules and laws of war will vanish, and as no moral restraint will be left, civil centers will undoubtedly be bombed if only to bring the war to an end. Whether lethal gases, or vesicant chemicals, or high explosives are used is immaterial, but what is material is that nations will make the most strenuous efforts to protect themselves, and as these aerial bombardments are not likely to take place until the war is well advanced, and until the stalemate between the opposing mechanized armies provides an excuse for this form of attack, they may find ample time wherein to protect themselves against them.

HERE we are faced by yet another dilemma, namely: If world opinion should restrict air attack on cities, until all the greater powers have been sucked into the war, air defense may become strong enough to frustrate air attack. Are we destined then to be confronted by a complete stalemate, which can lead to peace only through sheer exhaustion? I do not think so, if it is realized that the secret of future air power lies in wireless control, that is, in electrical science. The air must wed the ether if air power is to dominate in war; and when this union is consummated, as I will now show, the offensive may become so powerful and so difficult to counter, that ultimately nations may decide that the game of war is not worth the candle.

Today should two hundred airplanes be despatched to bomb a city, each would be controlled by at least two men—here is the weak link. To hit the city they must fly over it; in other words, assault it. The city may be so strongly protected by antiaircraft defenses that the weak link will snap. The human element, the men in the machines, will not face the danger, any more than the infantryman today will face the machine-gun bullets of the defenses. Why assault? Why not in place hark back to our old friend the constant tactical factor, which whispers—"eliminate the danger." Why not send forward over that city two hundred unmanned and partially armored airplanes wirelessly controlled by, I will suppose, ten occupied ones flying at a distance from them, or at a high altitude above them? Each of these two hundred machines would be nothing more than a flying projectile—a true aerial torpedo—which will explode on impact with the ground, or be exploded by a wireless wave released by the airman directing them. Here the picture of the defense changes, for in place of shooting down human beings, the defender with his guns will bring down upon his city vast nerveless projectiles—in place of protecting the city each hit scored will throw it into panic.

What is the answer to this form of attack? Frankly I do not know. There may be an answer, and if wars are to continue there certainly will be an answer; but not one which will place all the great cities underground, for this is really unthinkable. Personally, I am inclined to hold the opinion, that anyhow for a long period, that is, as long as our present civilization lasts, wars will at some time in the future, and not a very distant future, be relegated to the dustheap of things which have failed, and which have outgrown their utility. Whilst in mechanical and chemical science I see possible fertilizers of war, in electrical science I see its possible end; for if an electrical wave can direct an unmanned airplane, as we know it can, it can direct and control an unmanned gun, or tank, or any other weapon static or mobile. The result of being able to move weapons, projectiles, etc., at a distance, and yet continue to direct their course, cuts out, not completely, but very largely the weak link in all past warfare—the human element.

For thousands of years man unconsciously has been working towards this end, in other words, willy nilly, he has been compelled by the costly process of trial and error to travel along the path of the constant tactical factor. The stone axe gave way to the primitive bow because man feared to be struck by the axe, the bow to the musket because man feared the arrow, the musket to the rifle, and so on. Obviously this progress has not been consistent, because it has depended upon the caprices of civilization, and man is far from being a logical animal. Now, however, as the secret of weapon evolution, one of the many forms of general evolution, is known, it is almost a certainty that it will be more and more closely followed; and once it is followed, the logical process of the elimination of danger on the battlefield will, so it seems to me, proceed to its logical end—the elimination of war itself.

7. *Summary and Conclusions*

LOOKING back on what I have written, which covers an extensive period of history, there can be no shadow of doubt, as far as this period is concerned, that the law of military development has been the interdependence of the progress of war and the progress of civilization. This being so, I think it may be inferred that this law will con-

tinue to govern the evolution of military organization in the future.

Though it is not possible to say what discoveries will be made by science before the present century closes, the constant tactical factor in war permits us to forecast that, whatever these discoveries are, when they are applied to military organization they will tend towards the elimination of terror and danger in military operations.

From this law and this factor, starting with armies as they exist today, we can establish a theory, namely, that once mobility is freely developed from protected offensive power, a reaction to this condition will at once set in, and will take the form of stability developed from protected defensive power. A stalemate will then follow, when once again mobility will be developed in order to overthrow stability.

This theory I have attempted to apply to the future of war, using as my medium present-day knowledge, and not attempting to describe what may happen if some purely speculative source of energy were to be discovered such as atomic energy.

Starting with the industrial revolution, which heralded in modern warfare, we may divide this epoch of war into three periods, namely, the periods of coal power, oil power and electrical power. The first entirely changed the organization of navies, vastly increasing the size of armies, and so potently enhanced their weapon-power that ultimately the defensive became the stronger form of war. During this period naval small wars were eliminated, naval great wars restricted, and through the economic interdependence of nations, begotten by steam power, great wars rapidly grew into world wars.

The next period, oil power, is the one which faces us today and which has heralded in mechanized warfare on the land and in the air. During this period military organization is likely to proceed along the following course: administrative organizations will first be motorized, then tactical organizations will be mechanized, and a high degree of strategical mobility will result. This will stimulate the idea of the defense, which by field and permanent fortifications will restrict mobility, and demand an extensive organization of defensive infantry. Ultimately, the defense will once again outbalance the offense, and a stalemate will occur. During this period small wars will be eliminated and great wars will be largely restricted.

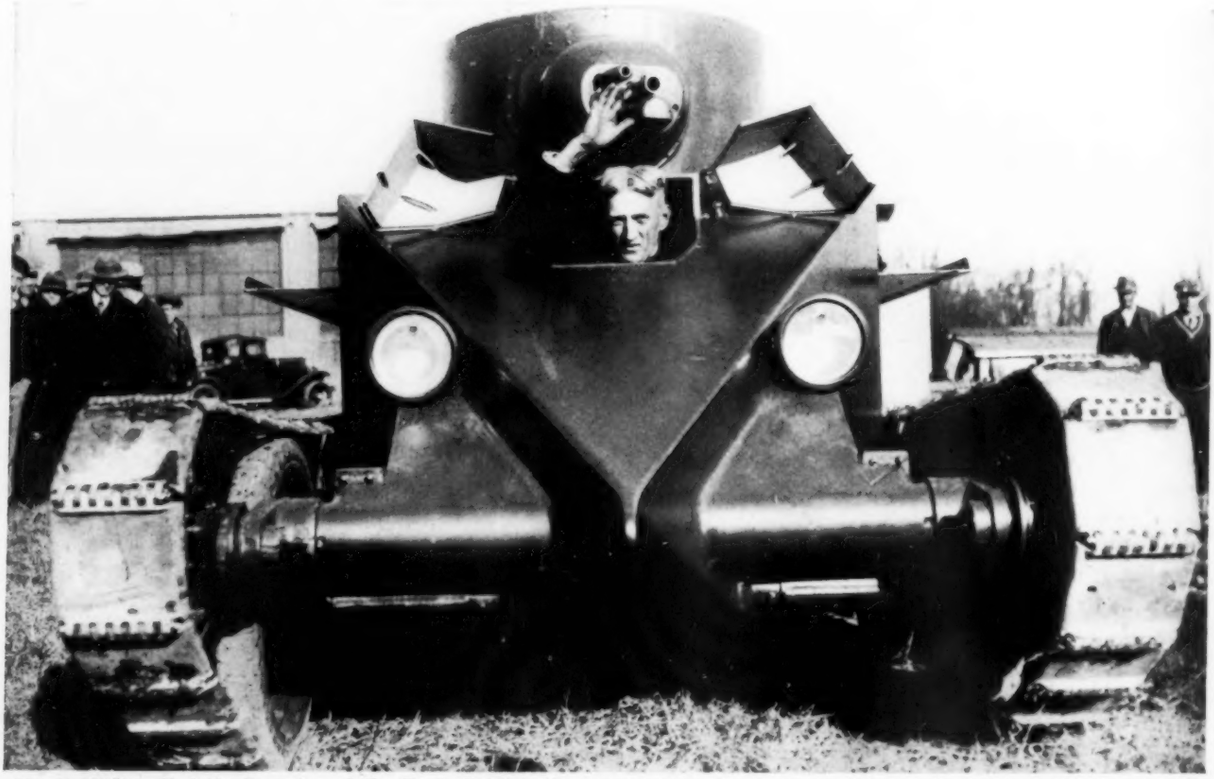
The third period, electrical power, also faces us today, and is still in its infancy. As the wireless wave is in more than one respect beginning to dominate civil life, accepting the law of military development, it will in the future as powerfully influence military life and organization. Urged forward by the constant tactical factor it will inevitably be applied to weapon-power, with the result that as battlefields become less and less dangerous, the areas behind them will become more and more dangerous. The shifting of danger from the fighting man onto the civilian is likely to cause such a reaction against war that universal peace will be established.

IT is true that the phases of war examined in this paper are not likely to be packed into the next few years, but that they may all find expression before the present century has run its course is, in my opinion, quite possible. The period immediately following a great war, on account of lack of money and incentive, is always militarily a comatose one. Thirty or forty years hence, when nations have recovered from the last war and new interests have been created, it is likely that military competition will once again begin, unless in the meantime human nature undergoes a profound change. When I think of the control room of the Hood and the quarter-deck of the Victory; the machine-gun and the flint-lock; of wireless telephony and the semaphore slowly wagging its arm from hill to hill; when I carry my mind back only seventy years, and see the electric telegraph, the railway, the rifle and the armored ship just beginning to emerge from out the laboratories of science and the workshops of industry; and then when I carry my thoughts forward seventy years from today, no speculation I have made seems to me impossible. All I have written may take form if my reasoning is logical, for logical speculation is the fulcrum of the lever of invention; and surely it is far more likely that warlike inventions, rather than peaceful sentiments, will one day be able to whisper into the ear of this troubled world—*pax vobiscum*.

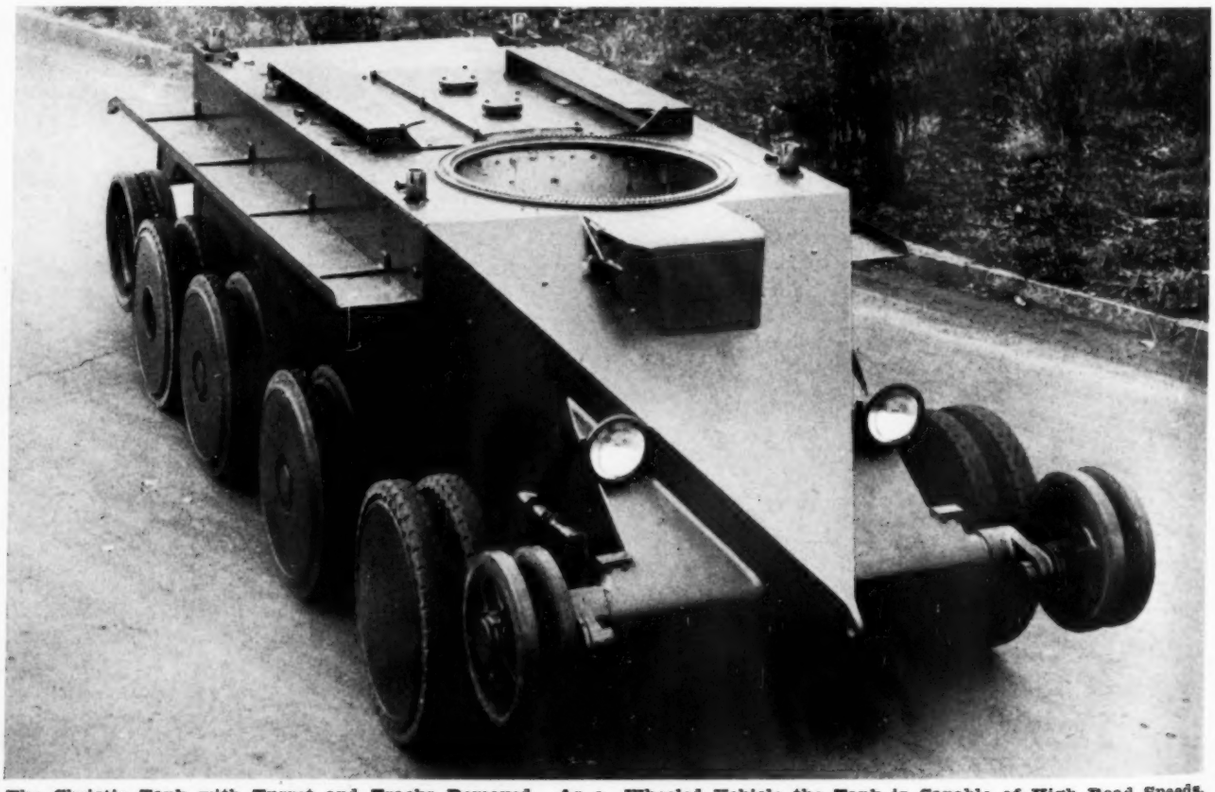
(This concludes General Fuller's article.)

British Mechanized Equipment During Maneuvers at Salisbury Plain.

The New Christie Wheel-and-Track Tank



Mr. J. Walter Christie, Inventor of the Tank, Driving the New Vehicle Shown here with Tracks for Cross-Country Travel.



The Christie Tank with Turret and Tracks Removed. As a Wheeled Vehicle the Tank is Capable of High Road Speeds.

New Fire Control for Divisional Weapons

Applications of Antiaircraft Methods to Field Guns

By G. M. Wells*

A CONSIDERABLE difference of opinion seems to exist at the present time regarding the mission of divisional artillery in future wars. There seems to be no question, however, but what this mission has changed considerably since the World War, in that it must in future include objectives such as high speed tanks, artillery prime movers, etc., in addition to stationary and slow-moving targets. There is also the somewhat controversial question concerning the secondary, or emergency, use of divisional guns as antiaircraft artillery. A fire-control system suitable for all these purposes will necessarily be somewhat elaborate and complicated if the matériel is expected to play an effective part in each rôle. The ultimate economy of proper fire control appears self-evident and, in the opinion of the writer, should require no discussion.

Battery of 3-inch Antiaircraft Guns with Automatic Fire-Control System. This Battery has been Used Successfully against Airplane and Naval Targets.

The deficiencies of the divisional weapons used in the World War have long been recognized and post-war developments have resulted in gradual improvements. Thus, the standard 75-mm. gun M1 presents noteworthy advances in range, elevation, traverse, and many other important characteristics. It does not, however, present any radical innovations or departures from design practice of the previous decade. During its period of development the changing missions of the divisional weapons were not clearly defined and little cognizance could be taken of them in the design. The result must necessarily be regarded as a gun which would have been a superior weapon in the World War, but which is somewhat unsuited to the changed conditions of the present day. The carriage is deficient in amount and rapidity of elevation and traverse, and is entirely incapable of withstanding the effects of high speed transportation on its own wheels. The fire control is deficient in that it does not include means for predicting the future position of a moving target, nor does it facilitate the continuous laying of the gun on such a point.

In 1929 the Ordnance Department inaugurated the design of two new gun carriages differing radically from the conventional type. These mounts, the 75-mm. carriages T2 and T3 have been described respectively by Capt. E. C. Goebert and Maj. G. M. Barnes in articles published in recent issues of this Journal. Both designs, while differing in many respects, were intended to meet the same general requirements, namely, ability to fire at fast moving terrestrial or celestial targets and an under-carriage construction adapted to high speed truck or tractor draft on improved roads or across country. The first requirement, of course, implies such additional characteristics as 360° traverse, 80° elevation and a stable firing platform. Both carriages were completed last summer and have recently been subjected to preliminary tests at the Aberdeen Proving Ground. The tests demonstrated that the carriages could be used effectively against ground or airplane targets provided suitable instruments were available for computing the firing data and continuously transmitting them to the guns. Standard antiaircraft fire-control instruments were used in the proving ground tests. These instruments were not, however, entirely suitable for field artillery purposes as will be explained later.

THE development of modern antiaircraft fire control really dates from 1925, although considerable study was devoted to the question in the years immediately following the World War. In the last five years the Ordnance Department, working in conjunction with instrument manufacturers at home and abroad, has developed and tested two satisfactory directors or computing instruments, several types of height and range finders, automatic electrical transmission systems and various allied instruments of lesser importance. It is important to note that these developments have been for the most part conducted with the antiaircraft problems as the only objective. It is also of great interest and importance to note that much of this work on antiaircraft fire closely parallels the requirements for similar instruments for ground fire.

Before proceeding with the discussion of antiaircraft instruments and their application to divisional artillery it will

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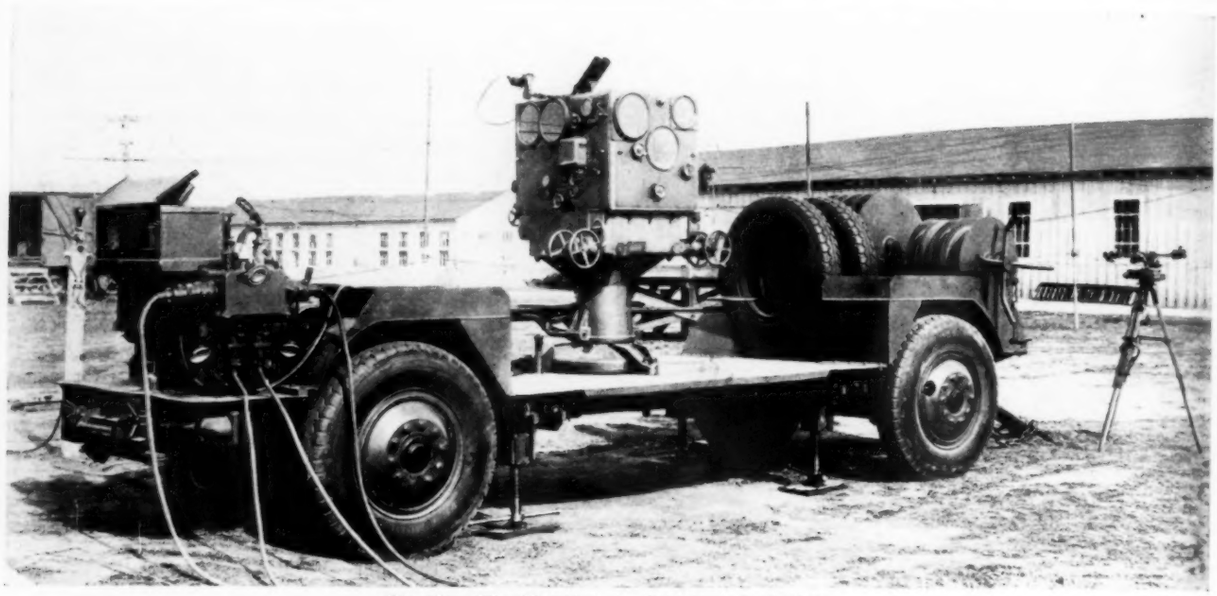


Director M2—Mounted on Instrument Trailer.
Note power plant and reels for transporting transmission cables. This director can be used against land or air targets.

be desirable to sketch briefly the fundamental information needed in computing the firing data for fast moving targets of all kinds. In the following summary it is interesting to note the similarity between the requirements for antiaircraft and ground fire.

First—The present position of the target. For antiaircraft targets, this position is defined by present azimuth, angular height and either altitude, slant range or horizontal range. For ground targets, present azimuth, angular height (angle of site) and either slant range or horizontal range.

Second—Speed and course of the target. Having the present position of the target, its speed can be determined for antiaircraft fire by measuring its vertical and lateral angular velocity with respect to the directing point of the battery. For ground fire, only the lateral velocity is necessary. The course is derived from successive or continuous determinations of the target's present position.

Third—Ballistic information. The range table time of flight and fuze range to the future position of the target are required for both antiaircraft and ground fire. Range table superelevation is an added requirement for antiaircraft. The effect of wind, drift, non-standard atmospheric density and muzzle velocity must be determined for both kinds of fire.

The foregoing data must be supplied continuously, with the possible exception of range or altitude which may be furnished at 2 or 3 second intervals without appreciably affecting the accuracy of fire. From these basic data, the fire control instruments must predict continuously the position of the target at the end of the time of flight of the projectile, together with the firing data to that point corrected for all abnormal ballistic effects. For indirect fire (Case III) the data supplied are range (or quadrant elevation), azimuth and fuze range. When the gun carriage is provided with sights and direct-fire methods are employed, vertical and lateral sight deflections may be substituted for quadrant elevation and azimuth.

Director M1A1—Suitable for Antiaircraft Purposes Only.

LET us now define and sketch the functions of the important instruments in the modern antiaircraft fire-control system. They are briefly—

The Height or Range Finder. A self-contained optical instrument which can be used to measure either altitude, slant range, or horizontal range of the target. It is usually provided with electrical equipment for automatically transmitting the measured data to the computing instrument or director.

The Central Station Director. A rather elaborate computing machine which by means of two integral sighting telescopes is made to measure the present azimuth and angular height of the target as well as its vertical and horizontal angular velocities. These data, together with altitudes or ranges received from the instrument previously mentioned, form the basis for continuously computing the present

Director M2—Mounted on Instrument Trailer.
This view shows the personnel required to operate the instrument for celestial and terrestrial fire.

and future positions of the target. This machine also computes and applies the ballistic corrections. It is usually equipped with electrical transmitters for automatically transmitting the firing data to the guns.

The Electrical Transmission System. A combination of electrical elements designed to display continuously at one position the data determined at another position distant from the first. It consists of transmitter and receiver generators and motors, cables, junction boxes, etc. It may operate on either direct or alternating current.

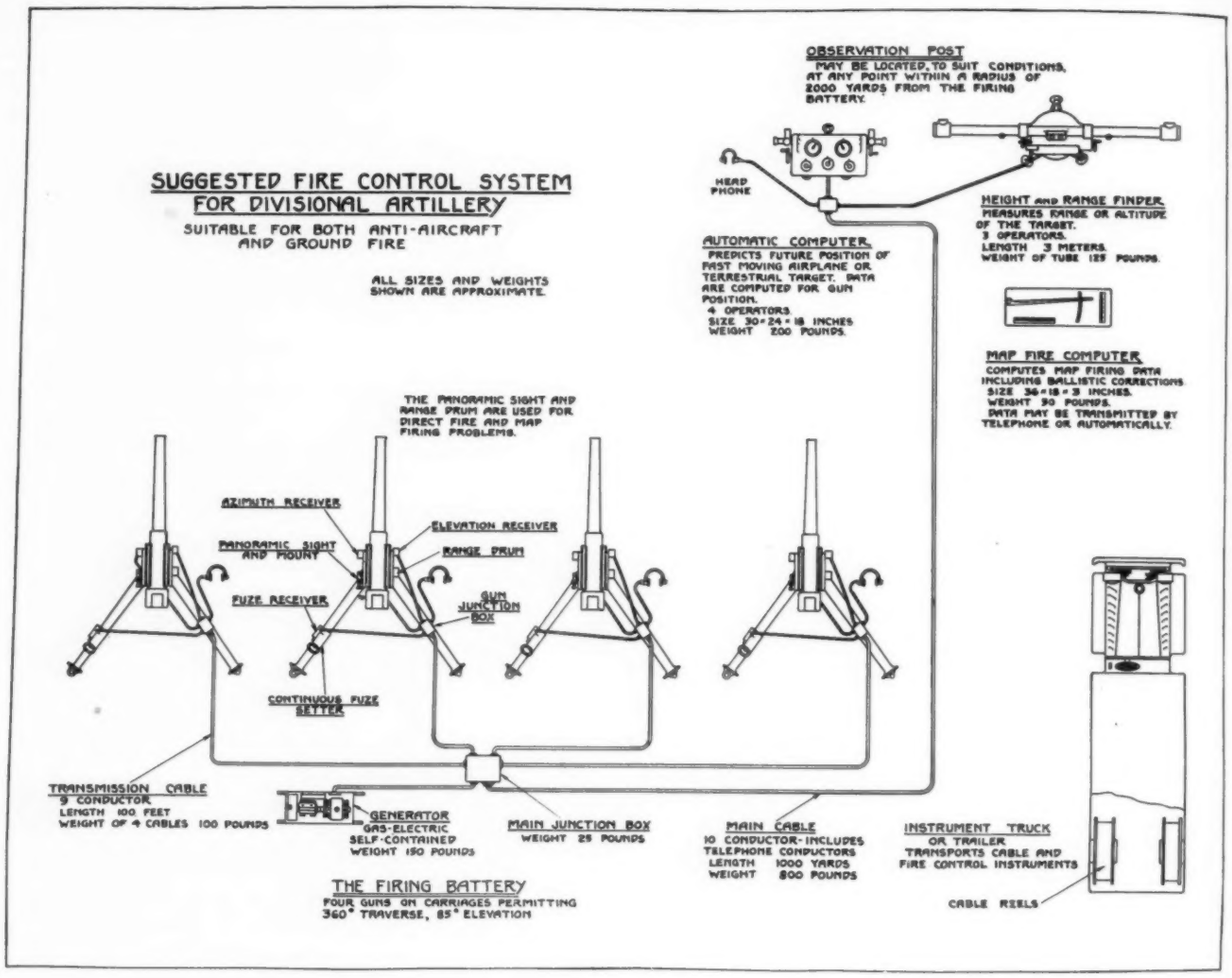
Any automatic fire-control system for use against fast-moving targets, whether they be terrestrial, naval or air, will consist essentially of the three elements just described. There are, however, a number of possible variations, for example, a two-station system of range finding, a combination of optical range finder and computer on the same mount, substitution of telephone for automatic electrical transmission, etc., but the essential elements still remain. It is only necessary then to determine the form of the three elements which will be best suited to the special needs of the divisional artillery.

The requirements for low weight, ease of handling, rapidity of set-up for action and freedom from maintenance troubles, are of course fundamental and apply in greater force to divisional artillery than to antiaircraft or seacoast weapons. Simplicity of design is desirable and has an important bearing on maintenance, but, as stated in an opening paragraph, is impracticable of attainment except in a relative sense.

The Direct Current Step-by-Step Data Receiver.

THE range finder for divisional artillery should unquestionably be a self-contained optical instrument. Two general types are available: the stereoscopic and the coincidence. The former is probably new to the Field Artillery, having been little used in this country until quite recently. Instruments of this type employ the well known function of stereoscopic vision, by virtue of which objects are seen in relief and in distinct relation to each other as to their respective distances from the observer. The coincidence instruments make use of the familiar split-image principle. The accuracy of either type is in direct ratio to the length of base and to the magnifying power of the optical system. A height finder is essentially the same as the range finder in that it measures directly the slant range of the target, but has in addition a mechanism for converting slant range to altitude. This conversion mechanism adds very little to the weight of the instrument and does not appreciably detract from its accuracy as a range finder. The change from range to altitude measurement can be made almost instantly by throwing a lever.

Several types and sizes of both coincidence and stereoscopic height finders, representative of the latest developments at home and abroad, have been procured and tested in connection with the antiaircraft program. The stereoscopic instruments have been found to be generally more accurate, at least against airplane


SUGGESTED FIRE CONTROL SYSTEM
FOR DIVISIONAL ARTILLERY
SUITABLE FOR BOTH ANTI-AIRCRAFT AND GROUND FIRE
ALL SIZES AND WEIGHTS SHOWN ARE APPROXIMATE
OBSERVATION POST
MAY BE LOCATED, TO SUIT CONDITIONS, AT ANY POINT WITHIN A RADIUS OF 2000 YARDS FROM THE FIRING BATTERY.
HEAD PHONE
HEIGHT AND RANGE FINDER
MEASURES RANGE OR ALTITUDE OF THE TARGET.
3 OPERATORS.
LENGTH 3 METERS.
WEIGHT OF TUBE 129 POUNDS.
AUTOMATIC COMPUTER
PREDICTS FUTURE POSITION OF FAST MOVING AIRPLANE OR TERRESTRIAL TARGET. DATA ARE COMPUTED FOR GUN POSITION.
4 OPERATORS.
SIZE 30 × 24 × 18 INCHES.
WEIGHT 200 POUNDS.
MAP FIRE COMPUTER
COMPUTES MAP FIRING DATA INCLUDING BALLISTIC CORRECTIONS.
SIZE 36 × 18 × 9 INCHES.
WEIGHT 90 POUNDS.
DATA MAY BE TRANSMITTED BY TELEPHONE OR AUTOMATICALLY.
THE PANORAMIC SIGHT AND RANGE DRUM ARE USED FOR DIRECT FIRE AND MAP FIRING PROBLEMS.
AZIMUTH RECEIVER
ELEVATION RECEIVER
PANORAMIC SIGHT AND MOUNT
RANGE DRUM
FUZE RECEIVER
GUN JUNCTION BOX
CONTINUOUS FUZE SETTER
TRANSMISSION CABLE
9 CONDUCTOR
LENGTH 100 FEET
WEIGHT OF 4 CABLES 100 POUNDS
GENERATOR
GAS-ELECTRIC
SELF-CONTAINED
WEIGHT 150 POUNDS
MAIN JUNCTION BOX
WEIGHT 25 POUNDS
MAIN CABLE
10 CONDUCTOR- INCLUDES TELEPHONE CONDUCTORS
LENGTH 1000 YARDS
WEIGHT 800 POUNDS
INSTRUMENT TRUCK
OR TRAILER
TRANSPORTS CABLE AND FIRE CONTROL INSTRUMENTS
CABLE REELS
THE FIRING BATTERY
FOUR GUNS ON CARRIAGES PERMITTING 360° TRAVERSE, 85° ELEVATION

and naval targets. They have the further advantage of permitting an accurate range sensing of the bursts with respect to the target. The greater accuracy is especially apparent under conditions of poor visibility. A very serious disadvantage lies in the difficulty in securing competent stereoscopic observers. Very few men are organically equipped for this work, and even when possessing a highly developed stereoscopic sense at least six month's initial training is required followed by refresher courses every year. On the other hand, any man possessing normal vision can be made a competent coincidence observer in a very short time. In spite of its disadvantages, the antiaircraft and seacoast service have standardized the stereoscopic principle, believing that the greater accuracy combined with the ability to spot, more than compensate for the difficulty in training observers. This policy follows present practice in the leading countries on the Continent of Europe.

The type of range finder best suited to the requirements of divisional artillery can be selected by the Field Artillery from comparative tests of experimental instruments already procured for the antiaircraft service. There are a considerable number and variety of both coincidence and stereoscopic height and range finders on hand, ranging in size from one to five meter base. The writer personally believes that a 3-meter coincidence height and range finder will probably be found most suitable for an arm whose primary mission is certain to be terrestrial fire. Such an instrument will weigh about 250 pounds and can be broken up into two loads for transportation. It will be reasonably accurate up to ranges of 10,000 to 12,000 yards, and competent observers can be trained with little difficulty. It can be used with equal facility against either terrestrial or airplane targets.

THE director, or automatic computer, is probably the most important and certainly the most interesting element of the fire control system. It is also logical to expect that it will offer the greatest difficulties in design and production. The computer for divisional artillery must first of all be of a size and weight which will permit of its being carried considerable distances by a limited number (not more than four) men. Its size should be limited so that it can be camouflaged fairly readily when set up in the limited confines of an advanced observation post. The number of operators should be held to a minimum, probably four, and the operations required of the manning detail must be simple and quickly learned. If the possibility of an antiaircraft mission be granted, then the computer must operate with equal efficiency against targets in the air or on the ground. Moreover, it should be possible to change from one class of fire to another instantaneously. It is extremely important that a parallax mechanism be incorporated such that the accuracy of the firing data will not be affected when the director is located in an observation post distant from the guns. It should be possible to apply spotting corrections at

the director, and have them included instantly in the firing data at the guns. The director should preferably compute Case III data only as a moving ground target seldom will be visible from the gun position. Provision for direct, in addition to indirect, firing data will add unnecessary mechanism and weight. Let us now examine these requirements in the light of our present accomplishments.

Two types of directors are now used by our antiaircraft forces. The first, a machine designed and manufactured abroad, has been the standard until quite recently. This director is quite satisfactory for antiaircraft purposes but has certain definite limitations which preclude its use with divisional artillery. It cannot be used against ground targets, and the absence of a parallax mechanism limits its use to the battery position. Moreover, it seems impracticable to modify the design to meet these important requirements. The second director, our present standard, was developed by the Ordnance Department in conjunction with a firm of instrument makers in this country. The design was predicated on the essential character of the ground fire mission, especially for antiaircraft guns in coast defense. No pains were spared in this development to obtain a director of the greatest theoretical accuracy, both in the prediction of the target's future position and in the computation of the ballistic data. No approximations or empirical relations were permitted and the director gives, theoretically, an exact solution of the problem. The basic ballistic data are determined and corrected for all abnormal conditions of atmospheric density, muzzle velocity, wind, drift, etc., by means of three-dimensional cams which reproduce the firing tables with great exactness in a mechanically usable form. Considerable attention has been given to the adjustment of fire and the facilities provided for this purpose permit of a very rapid adjustment against targets maneuvering in any direction, including a dive. The director was tested quite extensively last summer, prior to standardization, and was found to perform equally well against either airplane or naval targets. The percentages of hits obtained against maneuvering airplane targets were better than ever before. It was possible to adjust the fire quickly and accurately. This director will do the greater part of the things required of a computer for modern divisional artillery, but considerations of weight, cost and size of manning detail will definitely preclude its being used for this purpose.

THE question of a very much simplified computer has recently been receiving considerable study and the preliminary designs have now progressed to the point where a simplified machine incorporating all the important features of the antiaircraft director seems entirely feasible. A number of refinements, such as the ballistic cam mechanism will have to be omitted, but the remaining accuracy should be satisfactory for ordinary purposes. This is especially true in view of the fact that under field conditions the basic meterological data on which the ballistic corrections are based are often seriously in error. A parallax mechanism will be included such that no error will be introduced in the computation of the firing data when the computer is located at a considerable distance from the battery position. The simplified computer will weigh not over 200 pounds and will be operated by four men. It will deliver a continuous flow of Case III data. A contract has been let for the development, and the pilot machine will probably be completed in about one year.

It would of course be possible to simplify the computer still further by eliminating the antiaircraft features of the mechanism, and this would be the logical course to follow if it should be decided that divisional artillery will never be used against aircraft. The saving in cost and weight would not be as great as one would expect, probably amounting to not more than 25 per cent in each case. The number of operators would remain the same and there would be very little gained from a standpoint of maintenance.

Automatic transmission is practically a necessity in a fire control system deriving Case III data for fast moving targets. Since the computer gives at every instant the future predicted position of the target, and since the time interval used in the prediction is the time of flight only, it is apparent that the guns must fire without appreciable delay. This means that the guns must be laid continuously in accordance with the instantaneous values of the data from the computer. When this is done the rate of fire and timing of the individual shots have no influence on the accuracy of fire. The only delay in the whole system is the very small time interval between the removal of the round from the continuous fuze setter and the firing of the round in the gun. This can be accounted for by an arbitrary "dead time" correction at the fuze setter. It is theoretically possible to incorporate a large "dead time" correction in all data, to transmit the data by telephone and to fire at the end of the dead time interval. But experience has shown that this method is very unsatisfactory in that it retards the rate of fire very materially and tends to cause an abundance of personnel errors.

TWO types of automatic transmission have been developed for the antiaircraft service, namely, the direct current step-by-step and the alternating current self-synchronous. The latter is now standard for our antiaircraft matériel, but both systems offer important advantages. The D. C. system was the earlier type and is still used almost universally in foreign armies. The transmitters and receivers are less bulky than the self-synchronous type, fewer conductors are required in the transmission cables, and the voltage and current consumption are less, thus permitting the use of a small storage battery as a source of power. It has two serious disadvantages, the first and most important of which is lack of self-synchronization. This means that before the current is turned on the transmitter and receiver pointers must be set manually to the same reading. In the A. C. system, on the other hand, the pointers synchronize automatically. The second disadvantage of the step-by-step, or D. C., system is the tendency of the receivers to fall out of step with the transmitters when either the rate or direction of angular movement is changed abruptly. The same condition in the A. C. system results in a momentary lag followed by automatic resynchronization. The self-synchronous system requires a source of 110 volt A. C. power. This is supplied for mobile antiaircraft batteries by a small rotary converter driven by D. C. power from a storage battery. Since the current consumption is rather large, a gas-electric generator is furnished for charging the battery. The several elements of the power supply are permanently mounted on the trailer

used to transport the director and other fire-control instruments.

Neither the A. C. nor the D. C. system is suitable, in the present state of development, for transmission of data over long distances, say in excess of 1,000 feet. For greater distances it is necessary to resort to low resistance conductors and the cable becomes very heavy and bulky, and consequently difficult to transport and lay in the field. Experiments are now in progress which, it is hoped, will lead to the development of transmission apparatus, probably employing the step-by-step principle with important refinements, which will have very low current consumption and permit of using small, high resistance conductors. Needless to say, this development will have a very important bearing on the transmission problems of the divisional artillery.

SINCE the success of the long distance transmission project is, if not problematical, at least a matter of the future, let us see what can be done to adapt our present equipment to divisional artillery requirements. It appears to the writer that questions of size and weight of receivers, transmitters and especially cables, will restrict the choice to the step-by-step type. Three data receivers must be provided for each gun carriage, one displaying azimuth, a second quadrant elevation and the third fuze range. Each data receiver has two sets of concentric pointers; one driven electrically from the computer, and the other mechanically by the corresponding mechanism of the gun. The gun is kept laid continuously by the gunners on the future position data by matching pointers. Data receivers of this general type have been provided on the new divisional gun carriages mentioned above. The cables, junction boxes, etc., are shown schematically on a sketch which accompanies this article. The estimated weights of the several elements of the cable system are also given. Power will be supplied direct from a small portable gas-electric generator which will always be located at the battery position. The transmitters are a part of the mechanism of the computer. Telephone conductors are incorporated in the transmission cables with outlets at the junction boxes. Automatic transmission between the height-and-range finder and the computer is desirable but by no means essential, as these two instruments will ordinarily be located near each other. It is interesting to note that this transmission equipment would be the same if fire were restricted to ground targets.

The fire-control system just described can be used only against fixed or moving targets within view of the observation post, or point where the computer and range finder are emplaced. It will be of no value in connection with map firing problems. The gun data receivers cannot be used for direct fire missions, nor can they be used with map firing data unless the deflection is furnished in the form of azimuth and the range combined with the angle of site correction and converted to quadrant elevation. The transmission equipment might be used in a makeshift fashion for map firing problems by transmitting whole numbers without reference to the units in which the instruments were graduated. If this were done, all guns would necessarily be fired on the same data uncorrected for parallax of the individual gun positions.

It will probably be desirable to provide an independent fire-control system for map problems and for direct fire at targets visible from the battery. The "on carriage" equipment should comprise a panoramic sight and range drum similar to the instruments now used by the Field Artillery. If the gun carriage cannot be levelled it will be necessary to connect the sights and data receivers so as to correct the Case III data for the out-of-level condition of the carriage. This scheme is used in one of the new divisional gun carriages. The computation of map firing data can be simplified considerably by a special computing instrument designed only for this purpose. An instrument of this sort was issued recently to the Field Artillery for service test. It is so constructed that when placed on a map, the range and deflection can be read for each gun position without resetting. A simple mechanism is provided for computing the ballistic corrections. It is in reality a labor-saving device and does in quick and simple fashion what is now done by rather laborious hand methods.

It is realized that experienced officers of the Field Artillery cannot help but regard the size and complexity of this proposed fire-control system with some alarm. Let us analyze just what it will mean in the way of adding to the responsibilities of the organization commander. Training difficulties will not be increased as the duties of the operators on all the instruments are extremely simple, generally a matter of keeping two pointers matched. A special truck or trailer can be provided for transporting the instruments, and it should be possible to move this vehicle to the gun position with no more difficulty than would be encountered with a gun carriage. More time will almost certainly be required in preparing the battery for action, especially if the nature of the terrain is such that the computer and range finder must be carried a considerable distance to the observation post by hand. Reel carts can be provided for laying the transmission cable to the observation post and this operation should not be much more difficult than laying a telephone cable, if the terrain is not too unfavorable. The computer and guns must be oriented and the transmitters synchronized with the receivers. The first operation is fairly simple if a celestial body is visible or if datum points of known azimuth can be seen from both positions. Synchronization of the transmission system can be accomplished in a few seconds after the battery is oriented. Camouflage of the various positions, especially the observation post, will present added difficulties. The various instruments while "fool-proof" in normal operation, must be handled with reasonable care in transportation and will undoubtedly be more difficult to maintain than the very simple equipment now in use. Unquestionably, the organization commander must assume new responsibilities and will encounter fresh difficulties. It remains, then, first to clearly define the missions of divisional artillery and then to determine whether or not the increase in fire efficiency is sufficient to justify such a radical departure from previous equipment and methods.

EDITOR'S NOTE: For collateral data on antiaircraft fire-control systems readers are referred to the following papers which appeared in recent issues of this Journal: "Antiaircraft Artillery" by Maj. G. M. Barnes, Ord. Dept., U. S. Army (Vol. X, No. 56), and "Searchlights and Sound Locators" by R. E. Gillmor and P. R. Bassett (Part I, Vol. X, No. 59; Part II, Vol. X, No. 60; and Part III, Vol. XI, No. 61).

Fig. 1. N. Whitmore Muzzle-loading Target Rifle Used in the Tests Described in This Article.

A Muzzle-Loading Target Rifle

And Certain Factors Contributing to Accuracy

By Philip P. Quayle*

THE story has been told of a gentleman who, after imbibing too freely, visited a museum and on being confronted there by the mounted skeleton of a dinosaur, some sixty feet in length, exclaimed, "G'wan y'aint real." With a similar skepticism the shooting fraternity, as a whole, has received evidences of unusually accurate targets fired with muzzle-loading rifles.

In books such as Cleveland's "Hints to Riflemen," Barber's "Crack Shot" and others, are reproduced targets fired at ranges varying from 110 to 220 yards, the shot groups of which appear to be absolutely incredible in comparison with breech loaders. However, at ranges up to 200 yds. at least, it is highly probable that some of the most accurate shooting which has ever been done has been accomplished with heavy, muzzle-loading target rifles equipped with telescopic sights, set triggers, false muzzles and bullet starters.

It is the purpose of this paper to describe a test recently made with the rifle shown in Fig. 1, which is owned by Mr. Walter Cline, of Chattanooga, Tenn. Fig. 2 shows the rifle in its case with the mould, swedge, bullet starter, wiping rod and other accessories. This rifle was made by N. Whitmore and has the following specifications:

Length of barrel: 31¾ inches over all, including false muzzle and patent breech.

*Late Chief Physicist, Peters Cartridge Company, Kings Mills, Ohio. Captain, U. S. Marine Corps Reserve. Captain Quayle died suddenly February 21, 1931. He was a scientist of world-wide reputation, an active member of the Army Ordnance Association and a frequent contributor to this Journal. In presenting this article ARMY ORDNANCE pays tribute to Captain Quayle and his latest research.—Ed.

The rifling is cut on a gaining twist which, measured every 30°, reads as follows:

Angle	Distance from the Breech (inches)	Length for 30° twist (inches)
30°	6½	
60°	11 13/16	5 5/16
90°	16½	4 11/16
120°	21	4½
150°	24 7/16	3 7/16
180°	27¾	3 5/16

Bore diameter	0.432 inch
Rifling or groove diameter	0.448 inch
Depth of rifling	0.008 inch
Width of rifling groove	0.103 inch
Width of rifling lands	0.069 inch
Weight of the rifle, including false muzzle	16½ lbs.

The bullets of the flat-end picket type (Fig. 3) were cast from pure lead and then swaged, after which they were weighed and only those selected which were within 0.5 of a grain of the standard bullet weight used, which in this case was 225 grains. To secure the best results with a muzzle-loading target rifle of the type referred to in this paper the bullet should cut about half-way into the grooves, the patch filling the remaining space. The patch was of fine linen ⅞-inch in diameter and 0.007 to 0.008-inch thick. The powder charge giving the most uniform velocity consisted of 64.7 grains of FFG Kings Semi-Smokeless giving a mean muzzle velocity of 1,638 feet per second. All powder charges were weighed to within 0.1 of a grain. The caps used were those of the Winchester Repeating Arms Co., No. 12 Foil Lined.

This rifle was equipped with a set trigger of the single type and a full length telescope having a magnification of

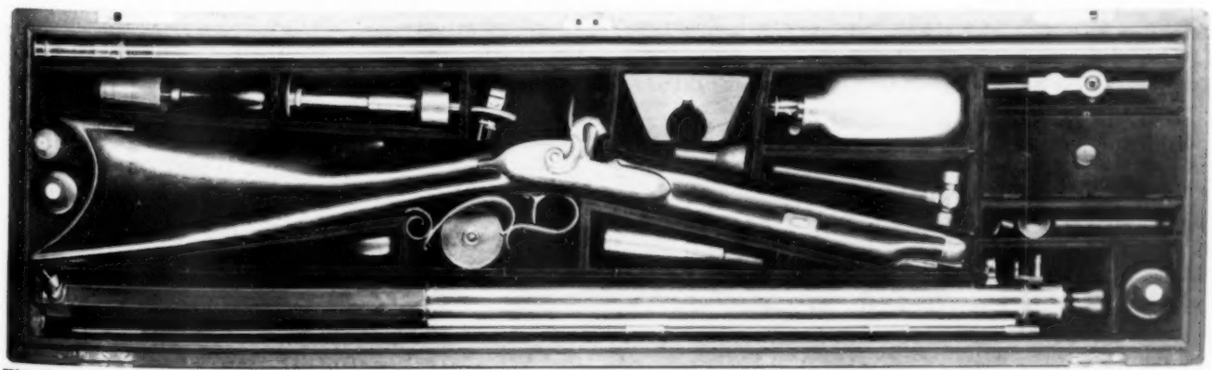


Fig. 2. The Whitmore Rifle in its Case, with Mould, Swage, Flask, Muzzle Rest, False Muzzle, Bullet Starter, Wiping Rod and other Accessories.

approximately 12 diameters. The telescope is adjustable for windage by means of a dovetailed piece let into the barrel at the muzzle. Changes in elevation are made by a finely cut elevating screw at the breech end of the telescope. In all the tests made with this rifle the bore was scrupulously cleaned after each shot.

Section	Height from Base	Diameter of Section
A	.10"	.435"
B	.19"	.425"
C	.29"	.412"
D	.38"	.393"
E	.48"	.358"
F	.56"	.325"
G	.64"	.271"

AS to the gain twist on which the rifling of the arm referred to in this paper is cut, no importance attaches to it as such but rather to the fact that the final twist of 1 turn in 40 inches approximately is particularly suited to the ball and powder charge combination of this rifle. The gain twist has its slowest pitch where the velocity is lowest and its greatest pitch where the velocity is a maximum, approximately. Furthermore the ball starts with one pitch when loading and has another when loaded, the process being reversed when firing.

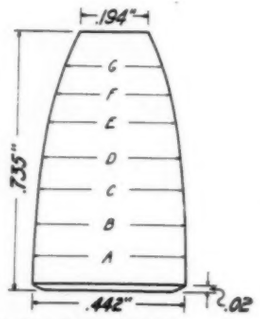


Fig. 3. Characteristics of the Lead Bullet (Flat End, Picket Type Ball).

In referring to this principle Busk says, "The principle is obviously unphilosophical for besides altering the shape of the bullet, it causes increased resistance at the muzzle ——." If the bullet does not strip or cut its patch when it leaves the muzzle the only effect of the rifling governing its flight is the pitch or rate of turning with which it left the barrel. This principle was recognized by Busk and other eminent writers of the period of transition from muzzle- to breech-loading arms.

After some experimenting in the laboratory with various powders and carefully measuring the velocity of the bullet by means of our precision oscillograph, a charge of 64.7 grains of Kings Semi-Smokeless powder was selected. With some of the trial powder charges the variation in velocity was such that a vertical dispersion of over 5 inches would have resulted from their use. It is evident that when the proper load is determined experimentally, as it was in this case, the arm in question has every advantage over those in which "cut and try" methods must be used owing to lack of the proper equipment. Much depends upon finding the charge which is best fitted to the arm in question, for a powder which gives excellent results in one rifle may be productive of great errors in another. A charge of powder which gives excellent results in a given arm with one weight and configuration of bullet may produce very unsatisfactory results if the bullet is appreciably modified.

IN the test of Mr. Cline's N. Whitmore rifle the arm was taken to the range in its case and there assembled. The bore was carefully wiped out and a cap snapped on the tube to be sure that it was clear. In this connection Forsyth in his excellent book "The Sporting Rifle and Its Projectiles" says of the double rifles then in use, "Snap a cap on each barrel, pointed downwards at a straw or such like, and if this is blown away by the gas, load." This is exceedingly good advice to heed in loading a percussion arm.

After it was determined that the barrel was clear, one of the weighed charges of 64.7 grains of Kings Semi-Smokeless powder was poured into the muzzle, using a small wooden funnel provided for the purpose. A felt wad 3/16-inch thick, which fitted the barrel snugly, was then seated down on the powder but not rammed. It is to be understood, of course, that the false muzzle is always in place except when firing. Having properly seated the powder charge and wad a linen patch 0.007- to 0.008-inch in thickness and 7/8-inch in diameter was first wet with saliva and then accurately centered in the depression in the false muzzle provided for this purpose. One of the weighed bullets was then placed accurately in the center of this patch, the bullet starter set in place and the bullet seated down into the rifling of the barrel by striking the plunger of the starter with the palm of the hand. The bullet starter on this rifle was so made that it would fit only in one position but on many of these old rifles the starter may be turned through 360°. With starters of this latter type both plunger and guide should be lightly marked, say with a center punch, and the punch marks should always be turned towards the sight or some other fixed position when loading. This precaution will eliminate variations due to any eccentricity in the starter itself.

After the bullet and patch had been seated in the barrel by the starter they were seated on the powder wad by means of a loading rod having a flat end. A loading rod with a concave end or a cavity fitting the nose of the bullet should not be used, because such a rod may alter the axis of the bullet as determined by the false muzzle and bullet starter. Here again the bullet is merely firmly seated on the powder. It is never rammed under any circumstances. In regard to this matter Busk says, "The instant the bullet is felt to have reached the powder, the rod should be withdrawn—no second stroke, however light, should be given."

After the loading has been completed the loading rod is withdrawn, the false muzzle removed, the cap placed on the tube and the arm is ready to fire.

TWO shots loaded in this manner were first fired to warm the gun and to settle the telescope in its clamping rings, after which five shots were fired for record as shown in Fig. 4. All firing was done with a muzzle and breech rest because the object of the test was to determine the maximum accuracy of the rifle. Only one target was fired, as the weather was very cold, and while by no means the best ever obtained, it is certainly very remarkable. All of the bullet holes may be covered by a silver dollar and all touch a five cent piece. The extreme horizontal measures 1 1/8-inch, the extreme vertical measures 7/8-inch and the mean radius is 7/16-inch. When it is considered that a width of 1 1/8-inch in 186 yds. represents an angle the tangent of which is about 1 in 6,000, the accuracy of this rifle and telescope combination appears well-nigh incredible.

The aiming point used in firing the target shown in Fig. 4 was approximately 15 inches below the group but as the group size was all that was wanted no attempt was

made to shift the center of impact, as the firing occurred late in the day and in failing light.

It is realized that an inspection of the target shown in Fig. 4 will, in many circles, provoke the remark of the gentleman alluded to in the first paragraph of this article. However, it should be noted that the best of the target rifles of the 60's were related in name only to their muzzle-loading contemporaries of the common type. Though it may be urged by some that the type of shooting described in this paper is impractical, still if the object in view is to hit the target with a minimum dispersion, then the Whitmore rifle referred to in this paper appears to be quite satisfactory.

PICKERING'S
MAIN & 5TH ST
CINCINNATI
TEMPERED
The group of 5 consecutive shots shown above were fired by Mr. E. Snider at a range of 186 yards on the 15th of January 1930 using a muzzle loading target rifle owned by Mr. Walter Cline of Chattanooga.
The charge used consisted of a linen patched picket ball weighing 225 grains and 65 grains of Kings Semi-Smokeless powder of FFg granulation giving a mean muzzle velocity of 1658 ft./second.
Telescopic sight, muzzle and breech rest.
Extreme horizontal 1-1/8"
Extreme vertical 7/8"
Mean radius 7/16"
Weather slightly cloudy with a light variable wind from 1 o'clock. Temperature about 30° F. Time 4:00 P.M.
Witnesses
Walter M Cline
Clyde T. Ervin
Martin F. Mathews
Philip P. Quayle

Fig. 4. Target Fired at 186 yards with the N. Whitmore Rifle Described in this Article.

IN case the reader may be fortunate enough to obtain one of these old rifles in good condition and wishes to repeat some of the target shooting described in this paper, a few general remarks on the subject of certain factors contributing to accuracy may not be out of place here.

Most of the target rifles of the 50's and 60's, particularly those of American make, were cut on a gaining or increasing twist, which in barrels of average length, say 32 inches, started with a pitch of approximately one turn in six feet and ended with one turn in three and one-half feet. It was obviously a somewhat difficult matter for the gunsmith of that day, considering the equipment available, to cut an accurate increasing spiral on a rifling guide. True it was occasionally accomplished but the usual result was a barrel in which the pitch of the rifling not only failed to increase but sometimes actually decreased for a given length and then increased again but at a rate considerably faster than the initial curve would have indicated.

In Fig. 6 is reproduced the curve of the rifling of Mr. Cline's N. Whitmore rifle in which the rifling starts with a pitch of one turn in six feet six inches and ends at the rate of one turn in approximately forty inches. In this case the work of rifling the barrel was beautifully done. There can, however, be little doubt but that the arm would shoot as well had it been rifled throughout at the muzzle rate of one turn in forty inches, since, other factors being correct, it is the rotational speed with which the bullet leaves the muzzle, for a given velocity, which governs its stability and not its previous history in this respect. But, it may be asked, if this is so then in what lies the disadvantage of the gain twist, or for that matter any other twist, if only its terminal rate be the correct one?

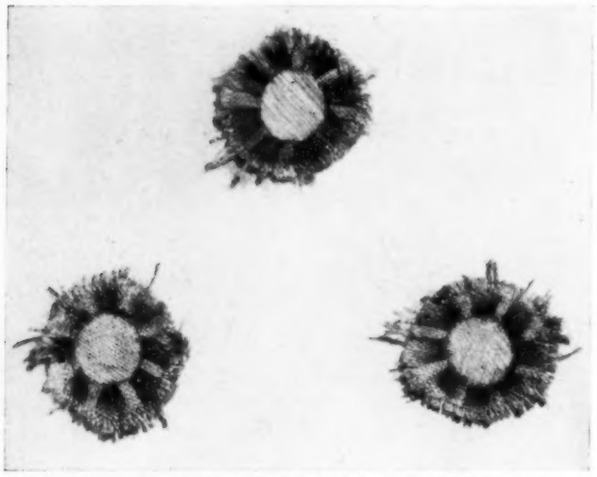


Fig. 5. Three Linen Patches after Firing from the Whitmore Rifle (.007 to .008-inch thickness)

IT will be obvious that the smoothest cut will be obtained when each tooth of the cutter moves in the same path as that of the one immediately preceding it. If moved obliquely rounded corners will soon result since in this case most of the work at these points must be done by the teeth at the front and at the back of the cutter, thus producing excessive wear at these points. Consider for a moment a rifling machine in which the cutter has been set in its holder at such an angle that its pitch, or inclination to the axis of the barrel, is one turn in forty inches. With such an adjustment of the cutter it will machine out its narrowest groove when, and only when, its holder is moved in such a manner that in traversing forty inches of the barrel's length it will make one complete revolution. In other words, the pitch at which the cutter is driven by the rifling machine must correspond to its geometrical pitch if the grooves are to be of the width of the cutter and uniform at muzzle and breech. For any other rate of driving the cutter, either slower or faster than its geometrical pitch, the rifling groove will be wider than that cut at the geometrical pitch. Thus in cutting rifling of the gain twist type we may set the cutter so that it will be correct at the breech for a pitch of say one turn in six feet in which case the groove cut at the muzzle, where the cutter will revolve at the rate of say one turn in forty inches, will be proportionately wider. Or we may set the cutter at the muzzle pitch in which case it will be wrong for the pitch at the breech and cut a wider groove.

A moment's consideration will show that if a bullet is forced into the muzzle rifling of a given piece at a rate of say one turn in forty inches the rifling grooves which are thus engraved upon it must undergo a considerable alteration when it reaches the breech at which the pitch of the rifling is one turn in six feet. This process is of course reversed again in firing with the result that the bullet and patch are more apt to be abraded or deformed with the gain twist than with the uniform twist, assuming equal workmanship in cutting the grooves. When such abrasions occur the bullet may leave the muzzle with one side of its patch torn off or with one edge of its base deformed in such a manner that the gas blast is unsymmetrically exerted upon it.

The region immediately adjacent to the rifle muzzle is one of the most critical in the entire flight of the bullet for in this region the gas blast attains an enormous velocity, even reaching magnitudes of the order of 10,000 feet per second in the case of the modern caliber .30 Springfield rifle. Since the velocity of this gas blast in the immediate vicinity of the muzzle is several times that of the bullet, any lack of symmetry in the base of the bullet results in an unsymmetrical distribution of the forces acting upon it. The resulting motion is similar to that of a bullet which has a portion of its base cut away.

IT is very doubtful if a class of rifles has ever existed in which the factors just considered will produce so evident an effect as in that of the muzzle-loading target rifle. Any tearing of the patch or any unsymmetrical arrangement of it upon the false muzzle, before loading, will produce an unsymmetrical distribution of the forces acting upon the base of the bullet as it leaves the muzzle. Hence in examining the rifling of one of these old arms be sure that it is first of all regular, by which we mean that if of uniform twist it should maintain essentially the same pitch throughout its length, or if cut on the increasing, or gain twist, the rifling curve should, when developed in a plane, form a smooth curve and not increase rapidly at one portion of the barrel and decrease at another.

It is obvious that the pitch of the rifling of a given arm may be geometrically correct and yet if the lands and grooves have not been smoothly cut both bullet and patch will be abraded and otherwise deformed. If this abrasion and deformation is sufficiently great no sort of good shooting need be expected from the arm. If upon examination of a given rifle the above details are not correct the most uniform of muzzle velocities and the finest ammunition components which can be produced will avail nothing since the errors which are introduced by the muzzle blast acting upon an unsymmetrical bullet base or patch are so great as to offset all other factors, however perfect they may be.

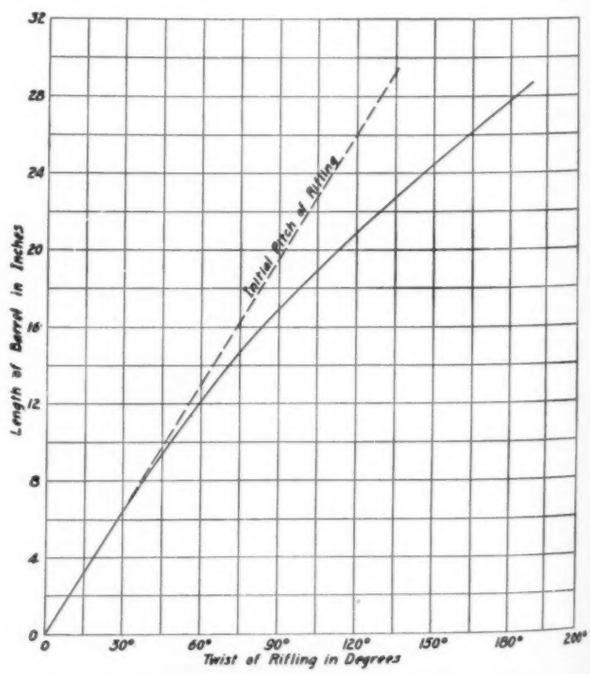


Fig. 6. Curve of Rifling of the N. Whitmore Rifle.

Ordnance Procurement Planning

The Peace-time Problem of War-time Munitions Supply

By O. J. Gatchell*

IT is the war-time mission of the Ordnance Department of the Army to furnish to the using services certain war matériel equal at least in quantity and quality to that of the enemy. This includes design, development, procurement, supply and maintenance. The war mission of the Department is in general like the peace mission except that it is upon a greatly enlarged scale and is hampered by the disruption of normal conditions. There will be, however, a change in relative importance of the work. In peace time the greatest stress is placed upon design and development of new matériel. In war time the stress will be upon procurement, supply and maintenance.

It is the specific function of Ordnance war planning in time of peace to make plans so that the Ordnance Department can perform its war-time mission most expeditiously.

The big factor which makes the Ordnance problem difficult is that most of the items which we supply have no counterpart produced commercially in peace time. In almost every instance new or converted facilities must be created and manufacturers educated to make something entirely foreign to their normal product.

Another factor which makes the Ordnance problem different from the average problem of the other supply branches of the Army is that there is no real comparison between peace and war requirements and no accurate ratios between man power and initial equipment, particularly in the earlier stages of mobilization. For example, in the case of ammunition, our annual consumption is a very limited quantity prescribed for target practice. Our war consumption is based upon rates of fire for particular weapons which have no relation whatsoever to target practice allowances and is vastly greater. A man eats approximately the same amount of food in war time as he does in peace time and requirements for clothing also bear a definite relation to man power. But the number of antiaircraft guns depends upon the number of antiaircraft regiments mobilized under a particular plan. Hence every item is different and has to be worked out in detail with no royal road to solution. This involves a great amount of clerical work which has to be done for every plan which the War Department promulgates. Various attempts have been made to determine ratios of requirements based upon man power units of 1,000 men, but without success.

The trouble is that the ratios are quite different during various phases of the mobilization period. For example, all the antiaircraft regiments are mobilized in the first period and none later. On the contrary, certain elements, such as laundry companies armed only with the pistol, are mobilized only in the later periods. Thus by the time the numerous factors are worked out, as much time and labor has been consumed as would be under our present plan. Furthermore, these ratios would change with every change in the mobilization plan.

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However, there is the possibility of a short cut which we are considering and that is the use of ratios between a weapon and the appurtenances that go with it. We know that in the *initial equipment* of the larger units there is a fixed ratio between the 75-mm gun, for instance, and the sights, limbers, caissons, range finders, etc. Thus if the requirements for the gun itself are computed for any plan, by use of such ratios it is believed that the requirements of the other appertaining items can be quickly determined. This system has not been worked out in detail yet, awaiting the completion of new Tables of Basic Allowances, and I wish to emphasize the fact that this applies to initial equipment only. However, the computation of requirements for wastage is comparatively easy after the initial equipment is known. In time of emergency, ratios and curves would of course be resorted to so as to meet changes in actual mobilization and operating conditions in accordance with the necessity for speed.

Another feature is the variation in wastage factors of ordnance matériel. The wear and tear on a truck used in peace time does not vary so very much from that in war. On the other hand, a 75-mm gun with proper care in peace time lasts for years, whereas in war, due to tremendously increased firing and destruction by the enemy, it is estimated that there will be a wastage of 8 per cent per month. Similarly, radically different wastage factors have to be established for all major items, and wastage in time of peace can not be used as a criterion. As a rule of thumb for commercial items, such as standard hardware and things of that nature, we have adopted a proportion that 7 days of intensive firing is equal to 1 month of normal warfare in the theater of operations, which is equal to 3 months' training in the zone of the interior and to 6 months' peace-time consumption.

TO explain how the war planning organization of the Ordnance Department works, it is necessary first to discuss briefly the organization of the Ordnance Department, as a whole. The Department is organized into four main groups: the General Office, Technical Staff, Manufacturing Service, and Field Service.

The General Office, includes the personal office of the Chief of Ordnance and administers affairs which are common to all units. It is divided into six divisions: Executive, Administrative, Fiscal, War Plans, Advisory, and Military Personnel.

The Technical Staff conducts research, development work and tests. It is divided into four divisions: Executive, Small Arms, Ammunition, and Artillery. It operates the Aberdeen Proving Ground.

The Manufacturing Service is charged with the procurement of ordnance matériel. To accomplish this work it is divided into seven executive and four operative divisions: Executive—Specifications, Raw Materials, War Plans, Arsenal Orders, Personnel, Facilities, and Finance. Operative—

Artillery, Ammunition, Small Arms, and Gage. Its field agencies are the fourteen district offices and the six manufacturing arsenals. In time of war it would also operate government-owned nitrate plants, loading plants, and proving grounds for acceptance tests.

AT this point I would like to expand upon the District Offices. The Ordnance Department initiated the idea of decentralized procurement during the World War. We believe the district organization to be the whole backbone of our procurement task both in peace-time planning and war-time performance. The personnel consists normally of a civilian district chief, an officer of the Ordnance Department as his executive officer, and a stenographer. We believe this force inadequate for the task but we are very limited as to funds for this work.

The District Chiefs are men of wide experience and prominent in business activities in their Districts, as well as men who are interested in the procurement problems of the Ordnance Department. In some cases they are reserve officers and in some cases not. As indicative of the character of men engaged in this work I would like to name these chiefs with their commercial affiliations. Baltimore: Mr. Howard Bruce, President, Bartlett Hayward Co.; Birmingham: Col. John Stephen Sewell, President, Alabama Marble Co.; Boston: Col. Charles H. Tenney, President, Chas. H. Tenney & Co. (Public Utilities); Bridgeport: Col. B. A. Franklin, Vice-President, Strathmore Paper Co.; Buffalo: Col. Ledyard Cogswell, Jr., President, New York State National Bank; Chicago: Mr. E. A. Russell, formerly Vice-President, Otis Elevator Co.; Cincinnati: Col. C. L. Harrison, President, Cincinnati Terminal Warehouse Co., and President, Board of Sinking Fund Commissioners; Cleveland: Mr. Henry C. Osborn, President, American Multigraph Co.; Detroit: (Vacant); New York: James L. Walsh, Vice-President, Guardian Detroit Co.; Philadelphia: Mr. John C. Jones, Vice-President, Cochrane Corporation; Pittsburgh: Mr. Frank B. Bell, President, Edgewater Steel Co.; St. Louis: Col. M. E. Singleton, formerly President, Missouri State Life Insurance Co.; San Francisco: Col. Bruce Cornwall, Caldwell, Cornwall & Banker.

The district office is expected to do everything practicable to insure that when war comes, it will be able to produce the items apportioned to it in the amounts and at the rates required. After M-Day its task is to put its war plans into execution.

THE Field Service is charged with storing, issuing and maintaining ordnance matériel after it is procured. It is divided into three executive and four operative divisions: Executive—Administration, Facilities, and War Plans; Operative—General Supply, Ammunition Supply, Maintenance, and Surveillance. It operates fifteen depots in the field.

In addition to the War Plans Divisions in the General Office, Manufacturing Service and Field Service, each operating division has a War Plans Section. Contrary to the Quartermaster system our war planning is very much decentralized. We believe that for our particular complex problems, at any rate, intimate contact between current activities and war planning is more essential than the efficient speed with which a centralized group can operate. Furthermore, with proper coördination, which we think we have provided, we believe it best to have each unit prepare the plans which it will execute in time of emergency.

Our organization is based upon the ability to pass from peace to war with least confusion. In the General Office there would be no change on M-Day except expansion. The War Plans Division would become virtually a requirements division to take care of the many changes in the troop basis which would be bound to occur. In the Manufacturing Service, again there would be expansion. The Automotive and Fire-Control Sections of the Artillery Division would become separate divisions. Similarly, the Aircraft Armament Section of the Small Arms Division would become a separate division. The War Plans Division would cease to operate the Districts and become purely a progress division. There would be no change in the Technical Staff or the Field Service except expansion. The various War Planning Sections in all the operating divisions are so small that they would be absorbed and would be valuable in putting plans into effect.

LET us now follow through an hypothetical example to see how this organization works for procurement planning. Assume the Field Artillery has expressed a desire for a 7-inch gun and the Secretary of War has directed that they be armed with that weapon.

a. Design—The first step is for the Artillery Division of the Manufacturing Service to design the gun in accordance with the general specifications of the Field Artillery as to weight, range, etc.

b. Approval of Design—This design is approved by the Technical Staff after consultation with the Field Artillery representative on the Ordnance Committee.

c. Manufacture of Pilot Gun—The Artillery Division would then order Watervliet Arsenal to make one gun.

d. Proving Ground Test—When the gun is completed it is subjected to proving ground tests at Aberdeen to determine whether it is satisfactory from the engineering viewpoint.

e. Field Test—After it passes the proving ground test it is turned over to the Field Artillery for a field test.

f. Adopted as standard—After all these tests are satisfactorily completed the Technical Staff, with the concurrence of the Ordnance Committee (which is composed of representatives of all branches) recommends that it be adopted as standard. Before approval by the Secretary of War, it must be approved by the Assistant Secretary of War as satisfactory from a procurement viewpoint.

g. Drawings, etc.—The Artillery Division then prepares a complete set of specifications, drawings, lists of parts, etc., from which copies may be readily made when needed.

h. Description of Manufacture—The Artillery Division then directs Watervliet Arsenal to prepare a description of manufacture for producing a unit number of these guns at a prescribed rate, based upon experience in making the pilot gun. This will be a method which can be used as a guide by commercial firms in making their factory plans.

i. War Plans Equipment Chart—To determine the initial equipment the War Plans Division, General Office, secures from the Office of the Chief of Field Artillery the equipment pertaining to this 7-inch gun issued to each unit armed with this particular weapon.

j. Wastage Factors—The War Plans Division, General Office, coöperating with the Maintenance Division, Field Service, determines wastage factors for this gun in the theater of operations and zone of interior and recommends them to the General Staff for approval.

k. Sets of Accessories, Equipment and Extra Parts—The Maintenance Division, Field Service, now determines the number of actually essential accessories, equipment and parts which will be necessary to maintain 100 of these 7-inch guns for 6 months of normal warfare.

l. Troop Basis—The next step is to secure from the General Staff a troop basis for the regiments armed with these guns showing rate of mobilization and rate of passing into the theater of operations.

m. Military Requirements—The War Plans Division, General Office, is now ready to compute the military requirements by month. These requirements must include initial equipment, overhead for distribution and wastage. Requirements must be computed for the guns themselves and for sufficient accessories, equipment and extra component parts to maintain the guns for their expected life in the theater of operations. The expected life of 100 guns is dependent, of course, upon the wastage factor of the gun. We assume for practical computing purposes that if the wastage factor of this gun is 5 per cent per month in the theater of operations, 100 guns would last 20 months. These requirements are compiled in a procurement set based upon the list of these items required to maintain 100 guns 6 months, which has been prepared by Field Service.

n. Procurement Requirements—Comparing these military requirements with any stocks which we might have on hand (which in this assumed case is none), the War Plans Division, General Office, then determines the monthly procurement requirements and transmits them to the Artillery Division of the Manufacturing Service.

o. Tentative Apportionment—The Artillery Division then tentatively apportions the requirements to one or more districts for procurement. (We will assume that Watervliet Arsenal is already loaded with orders to its capacity.) The tentative apportionment sent to a district is accompanied by complete sets of drawings, specifications, lists of parts, and the description of manufacture prepared by Watervliet Arsenal.

p. Gages—The Gage Division then designs inspection gages and determines tolerances, gaging points, etc. As an indication of the number of gages required for inspection it may be noted that 295 gages are required for a complete round of 75-mm. shrapnel. For the receiver only of the 1903 Springfield rifle 246 gages are required.

q. Estimates of Production—Assume that the Chicago District is one of the districts receiving an apportionment, this district then secures estimates of production from commercial plants within its jurisdiction, which it deems qualified to manufacture this 7-inch gun and makes report of same to the Artillery Division, Manufacturing Service.

r. Accepted Schedules of Production—The Artillery Division then prepares accepted schedules of production for the plants which have been selected for the Chicago District and similarly to other districts to which apportionment has been made.

s. Total Estimated Production—The Artillery Division reports the total estimated production, by month, to the War Plans Division, General Office, to be used in computing a war reserve of this item sufficient to tide over until production can meet requirements. The War Plans Division, General Office, forwards a copy of this production estimate to the Field Service to be used in preparing its supply plans.

t. Factory Plans—Each plant which has been selected for this manufacture then makes a factory plan to meet the schedule which it has accepted, using in so far as it sees fit (depending upon its particular equipment) the description of manufacture which has been furnished it.

u. Specific Procurement Plan—The Artillery Division, Manufacturing Service, then prepares a specific procurement plan and submits it to the Assistant Secretary of War as the solution of the procurement problem of this 7-inch gun.

What I have outlined is the ideal for which we strive in accordance with our organization. I do not wish to convey the impression that in actual practice this ideal is realized. As a practical condition much of this work is done out of chronological order and much remains to be done in our war-planning program and considerable time will be required with the limited funds and personnel which are available.

THERE are other difficulties, besides lack of funds and personnel, which are inherent to the nature of the task itself and would have to be faced even if we had plenty of funds.

For instance, there is the question of rearmament. In the above example I spoke of the 7-inch gun being adopted as standard. To designate a gun as standard means that it is believed to be the best of its type available and is authorized for both procurement and issue. An item is "substitute standard" when it is not considered the very best but is suitable and is authorized to be issued and to be procured only if necessary. An item is "limited standard" when it is believed fit to be issued to meet requirements but no more will be procured. Let us take the 75-mm. gun carriage for example. The recently produced M1 carriage is standard, the French M1897 is substitute standard and the British and M1916 American are both limited standard. If we had ample funds we would rearm our Army today with the M1 carriage. Also we would fill our war reserve with it and discard the others. But we cannot do that so we have to consider when and how we will rearm in case of emergency. We do not believe we can produce the M1 carriage in quantity under one year, whereas we believe that we can, due to past experience, produce the French carriage (which is substitute standard) sooner than that; we know our present stocks of all kinds will be exhausted in a major emergency in less than one year. So the obvious thing to do is to manufacture some French carriages to tide over until the M1 carriages can be produced. The decision was made to start the change at the end of one year which means plans must be made to taper off production of the French carriages as the M1's come in. This requires careful planning and is further complicated by the fact that the ammunition for the new M1 gun, due to its longer cartridge case, will not fit the old guns. So the ammunition program has to be kept in step. This situation is now further complicated by the so called "all purpose" gun which may cause an overthrow of all or many of our existing plans for divisional and antiaircraft artillery.

Another problem is the proper use of ammunition components which are on hand. The sudden stop of the World War and its resultant closing out of war contracts left us with unbalanced stocks of shell forgings, cartridge cases, fuze bodies, etc. Salvage of good components from ammunition which has become unserviceable has further upset the balance of these stocks. Our procurement plans, therefore, have to be based upon using them to best advantage.

IT is very difficult to place accepted schedules of production for complete rounds of ammunition. The various components are too dissimilar. This fact, added to the unbalanced stocks of components on hand which I just mentioned, means that there must be loading plants established for the assembly of the components. Due to the importance of this problem it has been decided to make these government-owned and operated. The present tentative plans, which are not yet approved, call for first-phase loading plants and second-phase loading plants. The first-phase loading plants are improvised production plants which are to undertake the loading and assembly of available components at the earliest possible moment. They will make use of existing buildings and facilities at Field Service establishments. Second-phase loading plants are large production plants to be constructed for the loading and assembly of ammunition components to be manufactured. In this they will be assisted by the first-phase plants. Picatinny Arsenal with its present equipment will, of course, take care of a certain amount. We are establishing three renovation plants with which we expect in time of peace to renovate deteriorated ammunition. At the outbreak of an emergency there will be some renovation work still to do, of course, but it is expected to complete that as promptly as possible and then use the renovation plants for loading and assembly in so far as possible.

Another special problem which the Ordnance Department has to face is the question of additional proving grounds for acceptance tests. Aberdeen Proving Ground will be entirely inadequate in a major emergency for proof firing of all the guns and testing of lots of ammunition which will be procured. It is expected to install six of these proving grounds, the basic plans for the layout and operation of which are contained in the unit war plan of Aberdeen Proving Ground.

ONE of our greatest tasks is the computation of requirements for extra parts, accessories and equipment. It is not a particularly hard task to compute the requirements for sets of essential parts, etc. pertaining to items to be manufactured after the sets are once agreed upon; but to figure out the parts necessary to maintain guns, carriages, etc., which are on hand, is a very complicated problem. The war left us with entirely unbalanced stocks of spare parts and it is necessary to compute the requirements for each individual part, instead of computing by sets. In spite of the fact that we compute requirements for essential parts only, the number of such reaches well into the thousands and the work involved is tremendous.

Another problem which is being given considerable study is that pertaining to the procurement of optical instruments. This involves in general two separate problems; the procurement of the necessary metal components and the production of the optical elements. There might also well be added another problem which is involved in the assembly operations. We find it impossible to apportion complete instruments due to the fact that very few facilities are capable of producing the complete items. Facilities can be located that are capable of producing the metal parts, but relatively few facilities exist which are capable of producing the necessary optical elements. The real problem, therefore, is the procurement of these optical elements. Frankford Arsenal is working on this problem and it is rather probable that it will be necessary to have a war reserve of optical glass.

THE procurement of hydro-pneumatic recoil mechanisms is another puzzle for us to solve. These are extremely difficult to manufacture. During the last war satisfactory mechanisms were produced by certain commercial companies, but it was only after considerable experimentation and after many difficulties had been surmounted. The knowledge gained by these companies will no doubt have been lost to a great extent by the time another emergency may arise and therefore the Department has adopted the policy of making Rock Island Arsenal the principal source of supply in an emergency. It is not believed that the capacity of this arsenal will be sufficient to take care of our total requirements, but all orders for such mechanisms are being placed there, leaving to it the problem of securing such assistance from commercial facilities as may be necessary.

In the design of ordnance matériel every effort is made to insure the best product possible. Usually, limitations as to weight or size make it necessary to utilize the best materials without paying much attention to their strategic value. In recent designs, however, this question has been given due consideration and good results have been obtained.

Another problem which faces the Ordnance Department and which must be under constant consideration is the constant change and development in manufacturing operations.

For example, the cold-working method of making cannon has a marked effect upon the production programs for guns and descriptions of manufacture for the old shrinking process are becoming more or less obsolete for smaller calibers.

A new development in cannon manufacture is the centrifugal casting of guns by which molten metal is poured into a rapidly turning mold and the metal is cast upon the sides of the mold in the shape desired. The results which have been obtained from this method are most promising and may further revolutionize the making of small guns.

The adoption of seamless tubing for the manufacture of projectiles in place of the old method of punching them out of a billet bids fair to have considerable effect upon production schedules of shell.

The rapid changes in the machine tool industry also require careful consideration. Since the war the machine tool industry has gone ahead by leaps and bounds and many machines believed to have been very fine a few years ago are now obsolete. Competition requires commercial firms to have the very latest machine tools for speeding up manufacture and thus a description of manufacture which involves the use of certain machine tools may be almost useless

to a commercial firm equipped with more modern types.

TO make war planning complete and in order that reasonably accurate estimates as to power, labor, new construction, etc., may be gotten, it is absolutely necessary that the commercial firms who have accepted schedules of production prepare factory plans. They are really the heart of our procurement planning but unfortunately constitute one of our hardest problems. No funds are appropriated for this purpose and a good factory plan will cost anywhere from $5,000 to $15,000, if not more. Most firms are loath to undertake this work without some assistance from the Ordnance Department. This is particularly true for firms which have agreed to make a product foreign to their normal peace-time output. At a meeting of the district chiefs a year ago a resolution was unanimously adopted to the effect that if real progress is to be made in factory plans, each district should be furnished with one or more production engineers, either officers or employees of the Ordnance Department, who could devote their time exclusively to energizing and assisting commercial plants in this work. We have no way of forcing factories to make these plans, and all we can do is urge them. It is believed that as more descriptions of manufacture are made available, it will be somewhat easier to get factory plans.

At last year's meeting of the Ordnance District Chiefs a scheme was adopted by means of which a plant can be accurately surveyed and essential data pertaining thereto determined prior to the preparation of a factory plan. This scheme roughly is to convert the description of manufacture into "machine tool hours" and, with that as a yardstick, to measure the plant in question. It is believed that the scheme is quite practicable and will result in much more accurate information, particularly with respect to the utilization of existing facilities for early production. This scheme would not take the place of complete factory plans but would be an intermediate step to secure the most essential data. It has been studied by several prominent industrial engineers and has been heartily endorsed by them as being feasible and desirable.

This leads me to the last of the special problems, and that is the question of "educational orders." This means, briefly, the placing of small orders with commercial firms in time of peace to give them experience in ordnance manufacture. At present this is prohibited by law if the work can be done at arsenals. Attempts have been made for new legislation to permit this procedure, but so far without success. Returning to factory plans, I might say that in the legislation which it is hoped to have passed providing for educational orders will be a proviso that a firm with whom an educational order is placed will have to make a factory plan for that item. Of course even if legislation is secured it is not expected that there will be an appreciable amount of money appropriated, so that the actual number of factory plans thus produced will probably not be very great but once the idea is initiated and legislation secured there will be opportunity for growth. We feel that educational orders and factory plans are extremely important factors in true procurement planning but so far it has been impossible to make much progress in this direction.

NO discussion of procurement planning is complete without some reference to the war reserve. Practically every military authority now seems to be agreed that with equal starts new man power can be supplied to the fighting front well ahead of new munitions which have to be produced. This is particularly true of ordnance matériel and in order that the supply of ordnance to the fighting troops will be sufficient and adequate until such time as industry can meet the demand there must be a sufficient war reserve. If such a war reserve is not sufficient or up-to-date there will be an interval in any major conflict when our troops will be without sufficient guns and ammunition. War reserve is computed for what we call essential items only, i. e., items which are absolutely necessary to the fighting troops and which cannot be procured in the time and quantity necessary. Our war reserve is computed by comparing the cumulative requirements as laid down by the General Staff with cumulative estimated production as approved by the Assistant Secretary of War, and taking the maximum deficit or discrepancy between the two.

In closing, I wish to emphasize the point that I have tried to bring out throughout this article; namely, that although during the past twelve years the Ordnance Department has accomplished much in procurement planning there still remains a great deal to do. So far we have only partially completed the foundation consisting of learning where we would place orders for major items in time of an emergency. The superstructure, consisting of factory plans, estimates of new construction, power requirements, etc., and requirements for commercial items such as oil cans, screw drivers and the like, scarcely has been started.

Ordnance R. O. T. C. Summer Camp on the West Coast

(*Right*) The snow-covered peak of Mt. Rainier can be seen from the Ordnance Summer Camp at Fort Lewis.

(*Left*) Ordnance R. O T. C. Students Ready to Fire a 155-mm. Gun.

(*Right*) "Home Ram"! Ordnance R. O. T. C. Students Loading a Coast Defense Mortar at Fort Casey, Wash.

(*Left*) The Rifle Range at Fort Lewis—A Fascinating Duty for the Ordnance R. O. T. C. Students.

Ordnance Training on the Pacific Coast

Courses of Summer Instruction for R. O. T. C. Students

By I. A. Luke*

TO those who are interested in ordnance preparedness, the training of young college men to fill the ranks of the Ordnance Reserve Corps is of paramount importance. The necessity of developing all possible eligible candidates for commission as second lieutenants is apparent when we realize that over twelve years have elapsed since the armistice following the World War, and these twelve years have placed even the youngest of the officers of that period in the beginning of the middle-aged group. To realize this lapse of time somewhat concretely, the boys entering college today were on an average about three or four years old when the United States entered the last war. The vast majority of them have rarely had an opportunity of seeing much more than a company, or battery or two, at a parade, and have, of course, but little conception of the almost superhuman task placed on the nation when it becomes necessary to go from a peace to a war footing.

Yet it is from these young men that the vast majority of our future officers must come. It is necessary so to present the Reserve Officers' Training Corps courses during the normal four years of college life that the student will have his interest aroused to the magnitude and scope of the problems confronting the Ordnance Department, and to turn out the commissioned second lieutenant into the ranks of the Reserve with enthusiasm to carry on.

The courses given at the various institutions are designed to accomplish this objective. Once a student has completed two years of basic military work in any of the combatant arms he is eligible, insofar as military prerequisites are concerned, to enter the advanced courses, which are of two years' duration, and deal with subjects required of candidates for an Ordnance commission. These subjects include "Matériel, basic and advanced," "Military Law and Administration," "Ordnance Engineering," "Ammunition and Explosives," and "Organization of the Ordnance Department, Industrial Mobilization, and Property Accounting." The time spent by the student on such theoretical courses is approximately one-eighth of his entire study time in the junior and senior years.

In addition to the two years of theoretical courses, a summer training period of six weeks in camp is required. This training is entirely of a practical nature and is designed to supplement, as fully as possible, the theory given at the institutions.

Silver Cup Presented by the California Post, Army Ordnance Association, to Ordnance Units, R. O. T. C., on the Pacific Coast for Pistol Marksmanship. The 1930 Award was made to the Ordnance Unit, University of California.

Of the nine Ordnance R. O. T. C. units maintained at universities in the United States, three are located on the Pacific Coast, at the University of Washington, the University of California, and Stanford University. Owing to the distances and costs involved, the students from these units cannot attend the R. O. T. C. summer camp at the Aberdeen Proving Ground, Md., but must go to the best available camp provided for them on the Pacific Coast. This article deals specifically with that phase of the student's training, namely, the summer camp.

THE Ordnance R. O. T. C. summer camps on the Pacific Coast started for the first time about five years ago. Largely by reason of the planning of Maj. R. W. Pinger, Ord. Dept., and Maj. F. J. Atwood, Ord. Dept., a good foundation of practical ordnance training was laid. Owing to the facilities on hand at Fort Lewis, Wash., about two-thirds of the work has accordingly been carried out at that place, and the remainder at Fort Casey, Wash., one of the harbor defenses of Puget Sound.

From twenty-five to thirty-five Ordnance students have undergone training each summer. The number should in future increase as the students from the University of Washington reach the time when they are eligible to attend camp. This latter unit was installed in the autumn of 1929.

The program of instruction as conducted during the summer camp of 1930 is given on the following page.

*Leland Stanford University, California. Captain, Ordnance Department, U. S. Army.

Program of Instruction

Subject	Hours Allotted	Scope	Objective
(1) Physical Training	8	15 minutes of calisthenics and setting-up exercises before breakfast.	To train students in methods and to qualify them to act as instructors.
(2) First aid, hygiene and sanitation	6	TR 112-5, 113-5.	Lectures by Medical Officers with reference to hygiene and sanitation to be observed in camp, and the duties of an officer in the care of the health of troops.
(3) Ceremonies and Inspections	16	To include inspection of quarters, equipment, etc., and ceremonies.	To instruct students in the duties of officers, and N. C. O.'s at all usual routine inspections of quarters, full pack equipment, etc., and ceremonies, which will include reviews and parades.
(4) Drill and Command	25	Close order drill of squad, platoon, and company in accordance with TR 420-50. Daily except Saturdays, Sundays and holidays.	To qualify students as drill instructors. Student officers to be selected by roster and rotated in the positions of command.
(5) Marksmanship (a) Rifle	40	Preparatory and record practice in accordance with TR 150-5.	To familiarize student with the use of this weapon and methods of instruction in its use. Qualification.
(b) Pistol		Dismounted Course.	Qualification.
(6) Ordnance Field Service Storage	3.5	Inspection of Field Service activities at Fort Lewis.	To give student a general idea of Field Service activities including the mobile ordnance repair shop and warehouses.
(7) Proof of Guns and Carriages	44	Firing of weapons listed below.	To obtain such ordnance data as muzzle velocity, pressures, counter-recoil and recoil velocities, ranges, deflections, times of flight, dispersions, etc. These data to be used in preparing reports and completing problems assigned in connection with courses taken at the institutions.
		(a) Harbor Defense (Fort Casey)—20.0 hours (1) 3-inch Seacoast Gun—3 hours (2) 10-inch Seacoast Gun—11 hours (3) 12-inch Mortar—6 hours	
		(b) Mobile weapons 15.5 hours (1) 37-mm. Gun (Fort Lewis)—2.5 hours (2) 75-mm. Gun (Fort Lewis)—6.0 hours (3) 155-mm. Gun (Fort Casey)—7.0 hours	
		(c) Antiaircraft (1) 3-inch A. A. M1917 (Fort Casey)—6.0 hours	
		(d) Trench Mortar (1) 3-inch Trench Mortar (Fort Lewis)—2.5 hours	
(8) Ammunition Tests	7	Construction and tests of various types of shells and explosives.	To enable student to become familiar with methods of testing insofar as ammunition and equipment will permit.
(9) Range firing and reduction of firings	15.5	Calculation of results of firings listed under (7). Preparation of reports.	To familiarize student with duties of proof officers.
(10) Fire Control Instruments	3.5	Demonstration and discussion of Inf., F. A. and C. A. fire-control instruments.	To give general knowledge of these types of instruments.
(11) Tanks	3.0	Examination of 6-ton tank.	To give general knowledge of this item of ordnance.
(12) Chronograph, gaging and impression work	3.5	Demonstration and examination of available types.	To enable student to set up and operate a chronograph and to gage guns.
(13) Tractors and tractor repairs	9.0	Actual examination of artillery tractors.	To familiarize student with types.
(14) Automatic Rifle and Machine Gun	2.5	Firing of cal. .30 machine gun and automatic rifle M1918 in accuracy and penetration tests.	To familiarize student with use of these weapons.
(15) Field Maintenance	8.5	Work with Medium Maintenance Company at Fort Lewis.	To give a general idea of the equipment and uses of a mobile shop.
(16) Chemical warfare	3.5	Demonstration of grenades.	To give student a general knowledge of this matériel.
(17) Pyrotechnics	2.0	Demonstration at night of several types.	To give student a general knowledge of this matériel.
(18) Shelter tent instruction	2.0	Practical setting up of tents.	Practical instruction.
(19) Cleaning and turning in equipment	5.0		
(20) Trip to and from Fort Casey and inspection trip to DuPont Powder Works	18.0		
		TOTAL HOURS.....	225.5

THE instruction was very largely under the direct supervision of the Ordnance officers detailed to the camp, and these in turn were assistants to the executive officer detailed by the commanding general at Fort Lewis to supervise all R. O. T. C. training. There were Feild Artillery, Engineer, Medical and Dental units in attendance during the period the Ordnance students were undergoing training.

Keeping always in view the fact that officers were in the making, every possible opportunity to display initiative and leadership was given the students. A provisional Ordnance platoon was organized, and details of officers and noncommissioned officers were made by roster so that each student had actual experience in command.

IN the assignment of problems involving the firing of weapons, proof work, etc., a certain number of students, usually four, were designated as problem directors to carry through the entire work and the rendition of a report covering the problem when completed. These directors made all arrangements for the work, submitted lists of other available students required for details, lists of matériel, equipment, and ammunition needed, and at the appointed time supervised everything except the safety precautions, which were attended to by the Ordnance instructors.

There were nine of these major problems handled during the 1930 camp, as follows: (The objectives reached are stated under each.)

(1) The Browning Automatic Rifle and Browning Machine Gun.
   (a) Measurement of muzzle velocity by Aberdeen Chronograph.
   (b) Penetration tests using service and armor-piercing ammunition.
   (c) Dispersion pattern with machine gun at 50 yards range.
   (d) Actual handling and firing of each weapon by each student.

(2) The 3-inch Stokes Trench Mortar, Mk. I.
   (a) Measurement of times of flight.
   (b) Comparison of ranges obtained with range table ranges.
   (c) Plot of elevations versus ranges obtained.

(3) The 37-mm. Gun, M1916.
   (a) Determination of horizontal dispersion at approximately 1,700 yards range using full charge.
   (b) Vertical dispersion at 400 yards.
   (c) Determination of muzzle velocities with powder charges from 50 per cent to full charge, in increments of 10 per cent.
   (d) Determination of ranges for elevations from 29 to 55 degrees using full charge.
   (e) Times of flight.

(4) The 75-mm. Gun, M1897.
   (a) Determination of data for a range-elevation curve.
   (b) Determination of data for charge-pressure and charge-velocity curves.
   (c) Determination of data for a range versus powder charge curve, the gun being kept at constant elevation.
   (d) Measurement of recoil pressures.
   (e) Demonstration of a muzzle burst, a flashless round, and a "visible trajectory" by timed shrapnel bursts.

(5) The 3-inch Antiaircraft Gun, M1917.
   (a) Determination of data for a drift curve.
   (b) Times of flight and accuracy of fuzes.
   (c) Measurement of chamber pressures.
   (d) Determination of data for a trajectory plot.

(6) The 3-inch Seacoast Gun, M1903.
   (a) Determination of data for charge-pressure and charge-velocity curves.
   (b) Measurement of times of flight and ranges obtained.

(7) The 155-mm. Gun, M1918.
   (a) Using a constant elevation, the ranges, times of flight, chamber pressures, muzzle velocities, recoil velocities, recoil pressures and lengths of recoil were measured for powder charges varying from 60 per cent to 100 per cent strength.

(8) The 10-inch Seacoast Gun, M1895.
   (a) Measurement of chamber pressures; (b) measurement of muzzle velocities; (c) measurement of times of flight; (d) measurement of ranges.

(9) The 12-inch Mortar, M1895.
   (a) Measurement of chamber pressures.
   (b) Comparison of measured range with range table range.

In view of the fact that the students performed all the work of preparation, cleaning of the guns both before and after firing, erection of velocity screens, preparation of ammunition, reduction of data and submission of reports, it is seen that invaluable ordnance training was obtained.

All students must fire the dismounted pistol course and the Course D with the cal. .30 rifle. At the 1930 camp, this work proved to be intensely interesting and instructive. Twenty-eight of the thirty-two cadets attending camp qualified in one or both arms. Interest in pistol marksmanship was particularly enhanced by reason of a series of prizes given by the California Post of the Army Ordnance Association. One of these was a silver cup which went to the Unit at the University of California for the highest average pistol scores.

To the best pistol shot in each unit represented was presented a suitably engraved saber, and to the next best shot, a subscription to ARMY ORDNANCE. It may be remarked that the concrete support of the California Post, Army Ordnance Association in the matter of essay prizes and summer camp prizes, such as the above, is deeply appreciated, and is of great assistance in maintaining a high *esprit de corps*.

The social side of camp life was well looked after. A dance for the cadets was held weekly. Passes to nearby cities were freely granted, and during the Fourth of July holidays most of the men took the opportunity to go farther afield. Trips of instruction to the Bremerton Navy Yard, and the duPont Powder Works were made. A final day's outing at the Rainier National Park culminated the events of the camp.

The executive officer of the camp was Maj. F. W. Bowley, F. A., and the Ordnance instructors were Maj. W. J. Crook, Spec. Res., Capt. L. P. Crim, Ord. Dept., and the writer. The Ordnance facilities available at Fort Lewis and coöperating in the summer training were in charge of Maj. P. K. Kelly, Ord. Dept., and Capt. H. E. Minton, Ord. Dept., and included the supply and storage warehouses and the personnel of the 3rd Ordnance Maintenance Company.

Sensitivity of Nitroglycerin

Effects of Static Electricity on It and Related Compounds

By H. E. Nash*

IN discussions dealing with the cause of explosions on the nitroglycerin lines of dynamite plants, the possibility of the ignition of nitroglycerin by a static spark has often been considered. Definite conclusions on this question have seldom been arrived at because of our lack of knowledge of the possibility that static electricity could accumulate on the nitroglycerin line in sufficient quantity to ignite nitroglycerin. Of fundamental importance in these considerations are definite data which would aid in determining the quantity of static electricity necessary to ignite nitroglycerin. An attempt was therefore made to obtain this information.

In all probability the greatest hazard occurs with mixtures having the higher vapor pressures, such as those consisting of trinitroglycerin and ethylene glycol dinitrate, at times of highest temperatures and lowest humidity. If no danger were found to exist under these most severe conditions, it would be safe to assume that the hazard is at least no greater in any other case.

Tests were therefore conducted on a mixture of trinitroglycerin and ethylene glycol dinitrate having a moisture content below 0.15 per cent at temperatures at and above 50° C. (122° F.)

While the apparatus was available, a test was also made using a straight dynamite of 40 per cent strength, a sample of nitrosugar, a solution of dinitrotoluene in 2B alcohol, and propylene glycol dinitrate.

The method of measuring the danger of ignition of a material by sparks consisted in charging a condenser to a known potential and then discharging the accumulated electricity through an air gap including the sample. The apparatus was described in the January-February, 1931, issue of Army Ordnance (Vol. XI, No. 64, page 293). A high tension transformer and synchronous rectifier were used to charge the condenser. The condenser was then discharged through the sample. The gap containing the sample was enclosed by a water jacket for maintaining the temperature. This is shown in Fig. 1.

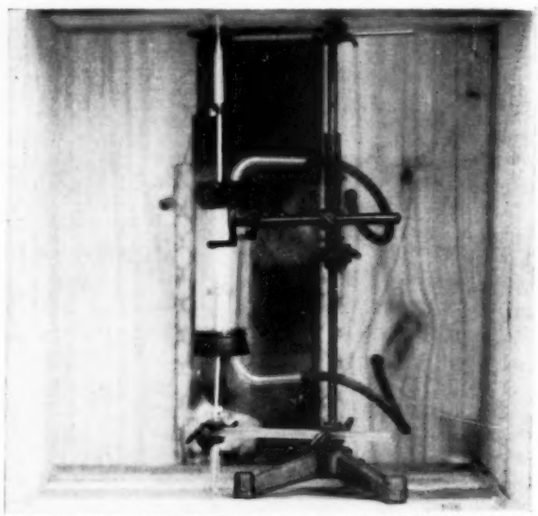

Fig. 1. Water Jacket Enclosure used to Maintain Temperature during Discharge of Condenser.

The liquid sample to be tested was added to a piece of thick filter paper until an excess above the amount absorbed by the fibers was plainly visible. The paper was then placed horizontally across the vertical gap. The paper fitted tightly in the inside tube of the water jacket so as to insure the presence of a saturated vapor above the filter paper. When it was desired to pass the sparks through a larger quantity of liquid than could be held by the filter paper, a small copper pan was used in place of the filter paper and the liquid poured into it.

A SERIES was first run with an undried mixture of trinitroglycerin and ethylene glycol dinitrate. Ignition was attempted on two samples. About 25 discharges were made through each sample. There were no detonations and no ignitions. In these runs the temperature and constants of the system furnishing the discharge were as follows: Temperature, T, = 55° C.; voltage, V, = 13,000 volts; capacity, C, = 0.0081 mfds.

A photograph of a discharge through filter paper, with water jacket removed, is shown in Fig. 2. In Fig. 3, two typical filter papers are shown, illustrating the size of the holes punched into the papers by the passage of sparks through them. The papers as shown are actual size.

Another series was run with the trinitroglycerin and ethylene glycol dinitrate mixture after drying the sample in a vacuum desiccator over calcium chloride for 24 hours. In the last run two filter papers were used with an air space of 0.1-cm. between them, thus insuring that the sparks passed through saturated vapor. The constants were: T = 60° C.; C = 0.0081 mfds.

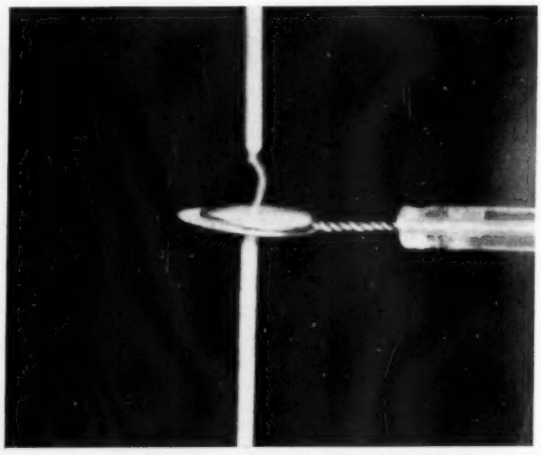

Fig. 2. A Photograph of the Electric Discharge through Filter Paper with Water Jacket Removed.

The runs are tabulated below—

Run	Volts	No. of Applications of Spark
1	10,000	50
2	5,000	50
3	10,000	50

About 0.1-cc. of thoroughly dried mixture of trinitroglycerin and ethylene glycol dinitrate was placed in a

*Hercules Experiment Station, Hercules Powder Company, Kenvil, N. J.

copper plate 1-inch in diameter and exposed to discharges from the condenser. The discharges were fully as severe as those listed above. There were no ignitions.

A similar series was conducted with a mixture of trinitroglycerin and ethylene glycol dinitrate that had been standing in a desiccator over calcium chloride for one week. There were no ignitions.

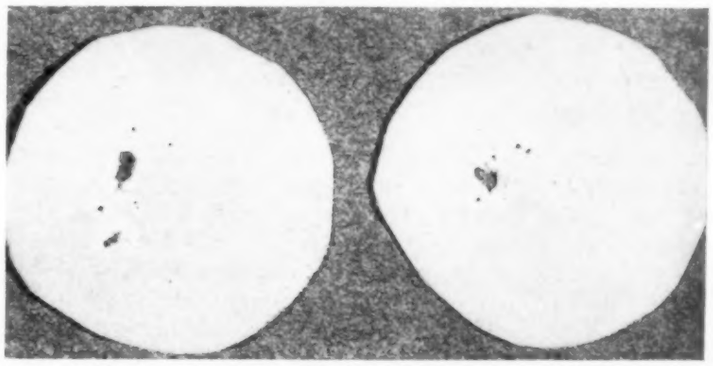

Fig. 3. Effects of Sparks on Filter Paper Illustrating the Size of Holes Punched through the Specimen.

One run was made using a 40 per cent straight nitroglycerin dynamite, at 50° C. The sparks applied were the most intense obtainable. After a few discharges the dynamite was found to have been moved out of the path of the sparks by electrostatic forces. Similar tests were conducted using a dry nitrosugar with identical results.

A series of tests were made using a 50 per cent solution of dinitrotoluene in anhydrous 2B alcohol. Ignition of the alcohol vapor occurred on the tenth application of the discharge. The constants were: T = 75° C.; V = 12,000 volts; C = 0.0081 mfds.

The above tests were repeated using alcohol only with varying values of capacity and voltage. The temperature of these runs was 78° C.

Voltage (volts)	Capacity (mfds.)	No. of Trials
13,000	0.008	one—ignited
12,000	0.004	one—ignited
19,000	0.002	one—ignited
3,000	0.002	Failed to ignite on 25 trials
3,000	0.002	Failed to ignite on 25 trials

In these tests it was noticed that whenever ignition took place the filter paper covering the charge was invariably charred about the hole through which the discharge had passed.

A sample of propylene glycol dinitrate was exposed to 25 intense discharges, without ignition.

MOST tests were conducted with the sample held on a piece of filter paper. This was done partly for convenience, but mainly because it was believed that, provided an excess of the liquid explosive was present, the finely divided liquid in the fibers would probably be the most easily ignited by the spark.

The electrical discharges used in this investigation were unquestionably more intense than those which could be conceived to exist on a nitroglycerin line. It is difficult to estimate how much more intense, but an attempt will be made to do so here.

The capacity of the condenser used in producing the sparks was generally 0.008 mfds. This is to be compared with the electrical capacity of objects existing on the nitroglycerin line. The capacity of a man, for instance, is less than that of a sphere having his height as diameter. The diameter of a sphere having a capacity of 0.008 mfds. is roughly about 500 ft. In estimating the capacity of other objects it is necessary to take into account the fact that there may exist some grounded surface parallel to one side of the object and separated from it by a dielectric. As an example of this, we can imagine a metal tank placed on a rubber mat resting on a grounded floor. In such a case the capacity of the tank is principally due to the condenser effect on the bottom. If the mat were ¼-inch thick, the bottom of the tank would have to be 17 sq. ft. in area to have a capacity of 0.008 mfds. Since a rubber mat is the thinnest dielectric, other than air, ordinarily to be met with in practice, the necessary size of the insulated object would vary from this up to 500 ft. for its longest dimension.

The voltage to be found on the nitroglycerin line depends upon the insulating properties of the dielectric. A static generator, although able to build up high voltages, is not able to supply much power and anything but the best insulators, such as Bakelite, very dry wood, new rubber free from dirt and graphite, will aid to quickly dissipate the charge. Current leakage through the air is of common occurrence; any rough edge or point serves to rapidly dissipate any charge built up on the insulated object.

The insensitivity of the mixture of trinitroglycerin and ethylene glycol dinitrate to static sparks is probably in a large measure due to its low vapor pressure—approximately 0.015-mm. Hg. at 25° C. Inflammable materials having a high vapor pressure, such as gasoline or alcohol, are easily ignited by a spark, but the ignition of liquids and solids by an electrical discharge is difficult to obtain.

STATIC electricity is not a hazard on the nitroglycerin lines. Intense discharges were unable to ignite the most volatile of the liquid explosives found on the nitroglycerin lines under the most favorable conditions that could be imagined to exist.

The discharges passed through the samples were far more intense than can be supposed to be present on the nitroglycerin lines. The capacity of the source supplying the discharges was about one hundred times the capacity of a man. Although the capacity was not excessively higher than could be imagined to exist, the possibility is extremely remote that a large object can exist on the line sufficiently well insulated to hold the necessary high potentials for intense and dangerous discharges.

EDITOR'S NOTE: The above article supplements the discussion by the same author on "Static Charges in Smokeless Powder" which was published in the January-February issue of this Journal (Vol. XI, No. 64, p. 293). The presence and effect of static electricity in nitrocellulose powders, dynamites and other explosive materials is the subject of considerable investigation by explosives chemists, because of the important relation of the subject to safety in manufacturing and handling operations in military and industrial practice.

ARMY ORDNANCE

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Month by Month

THE President of the Army Ordnance Association, Hon. Benedict Crowell of Cleveland, Ohio, was the recipient of a well-deserved honor when President Hoover recently nominated him to be a brigadier general in the Reserve Corps of the Army.

A Well-Deserved Honor

Army Ordnance takes pride in the honor which has come to the head of the Association. In addition to his preëminent war service as a member of the General Munitions Board in 1917, General Crowell performed outstanding service to his country as the Assistant Secretary of War and later as Director of Munitions during the World War. To him probably more than to any other individual is due the National Defense Act as it now stands in the organic law of the land. During the intervening years he has given most generously of his time and counsel to all matters connected with the national defense. He has served as President of the Army Ordnance Association since 1919 and he is also President of the National Rifle Association. The long delayed honor which has come to him is indeed deserved. On behalf of its readers Army Ordnance extends heartiest congratulations.

IN the War Department Appropriation Act, 1932, Congress placed upon officers and enlisted men on the active list of the Army a restriction prohibiting them from engaging "in any manner with any publication which is or may be issued by or for any branch or organization of the Army or military association in which officers or enlisted men have membership and which carries paid advertising of firms doing business with the Government." The War Department interprets the restriction to apply to "editing, directing, managing or any other active business relation with any such publication, direct or supervisory, with or without compensation." The Act specifically provides that nothing contained therein "shall be construed to prohibit officers from writing or disseminating articles in accordance with regulations issued by the Secretary of War."

Service Journal Legislation

The service publications, many of them in existence for a long time, are thus dealt a severe blow. Under the management of officers of the regular establishment they have aided very materially in maintaining esprit in their respective branches and at various posts and stations. Moreover, they are of inestimable value in the dissemination of current data to the officers and men of their respective organizations. It is hoped that under the new policies made necessary by the legislation they will be able to continue their very effective work for the national defense. That the advertising field has been abused in certain isolated cases is not to be denied. However, the sweeping effect of the legislation seems far too drastic. While some good will undoubtedly be accomplished by it the fact remains that a great deal of harm may easily result.

It should not be necessary to remind members of the Army Ordnance Association that their organization and this Journal are not affected by the new legislation. Ours is not a service organization nor is this Journal a service publication. From the start our Association has been governed by a board of directors none of whom is in active military service. Army Ordnance is not managed or edited by an officer of the Regular Army. Ours is essentially a civilian society managed and operated by civilians. That it is so constituted is another tribute to the men who established the organization twelve years ago. Their wisdom is shadowed in the effective work of the Association no less than in the means adopted for carrying it on. Both are far too vital to permit of faulty organization or procedure in the realization of the Association's main objective: to "assist in effecting industrial preparedness for war as our Nation's strongest guarantee of peace."

GENERAL PERSHING'S long-awaited historical narrative of his experiences during the World War has more than the inherent value of a first-hand account by one of the four leading military figures of the Allied cause. While this is certainly its greatest value, it has had the secondary effect of promoting worth while constructive discussion by individuals who are also concerned with the events described. Among these was the very enlightening comment upon certain phases of General Pershing's criticisms of munitions supply by Maj. Gen. William Crozier, U. S. A., Ret., who was Chief of Ordnance of the Army until December, 1917. Those who have followed the serial publication of General Pershing's book have noted his emphasis of the shortage of military supplies of all kinds with which we entered the war. He stresses the fact that, with few exceptions, no guns of American manufacture were used by the American forces in battle. This statement is obviously true although, as General Crozier pointed out, it does not give a correct impression of American artillery production.

Part of Our Munitions Job

Many students of the question have always felt that a major part of America's munitions effort included the vast quantities of munitions produced by American manufacturing establishments for our Allies. In some cases production under these contracts had been entered into prior to our formal entry into the war, and even though American requirements were so pressing the manufacture of equipment for our Allies was not interferred with but was allowed to

proceed to completion before American orders were placed.

In this connection we might mention, as examples, work of the Bethlehem Steel Company, the Midvale Steel and Ordnance Company and others. We recall that the Bethlehem Company at the time of our entry into the war was engaged in the production of 18-pounder field guns and carriages and 9.2-inch howitzers, complete, for the British. Work on these contracts was begun as early as 1915. Due to a disastrous fire at the Bethlehem plant, production was delayed unduly. They were completed, respectively, in July and September, 1918. In the case of the Midvale Company, which was engaged in the production of one hundred 8-inch howitzers under contract with the British, entered into in July, 1916, first shipments were made in May, 1917; final deliveries in January, 1918. Likewise in the case of the duPont Company and others, data could be adduced to show that production for our Allies was not molested upon our entry into the war but was allowed to continue on to completion.

General Crozier points out that over 14,000 gun forgings, a large number of other artillery components, and 2,000 complete artillery units were supplied for our own forces and those of our associates. These latter amounted to nearly 85 per cent of the total number of guns in action during the war.

And so in appraising the contribution of America to munitions supply in the World War the fact should not be overlooked that American industry was a major contributor to the Allied cause even before the requirements of the A. E. F. were pressing. To have allowed the continuance of this work and not to have ruthlessly substituted our own needs was probably even a greater contribution to American military effort than it would have been to have withheld such supplies for our own use. This was a real part of our job and the record should so state.

Death of Fritz Heigl

IN the recent death of Maj. Fritz Heigl, a retired officer of the Austrian Army, the development of mechanized warfare loses one of its greatest authorities. Major Heigl died in Vienna on December 11, 1930. He will be remembered by readers of this Journal and by all students of mechanization for the many works of his brilliant pen which marked him as a leading authority on tanks, armored cars and mechanization generally.

Major Heigl had a notable military record as an artillery officer during the World War. Following his distinguished Army career he became a lecturer and assistant professor at the Vienna Technical College where he qualified as a Doctor of Science. His encyclopaedic work *Taschenbuch der Tanks,* which has passed through several editions, the latest having appeared last August, was the leading source book on the characteristics of military automotive battle equipment of all countries. Friends of national defense everywhere will regret the untimely death of this talented gentleman and learned engineer. In the vital days of first mechanized developments, he performed an important service in collecting and analyzing the characteristics of tanks as adopted by all armies of the world. Major Heigl will go down as a leading figure in the annals of automotive defense.

A New American Gun Carriage

ENGINEERS and manufacturers interested in the progress of ordnance development will read with interest the article appearing in this issue of ARMY ORDNANCE by Captain Goebert on the development of a new gun-howitzer carriage to replace the 155-mm. gun — 8-inch howitzer vehicle of war and post-war days. Even though the carriage developed in conformity with the requirements of the Caliber Board was a startling improvement over the World War equipment, the limitations inherent in that piece were decidedly unfavorable in the light of modern automotive and engineering developments. The disadvantages of the standard matériel including its extreme weight, low speed of mobility and great quantities of auxiliary equipment required to make possible the transportation of the weapon, are of growing importance. The latest design of this carriage, aimed to overcome the inherent difficulties of the older piece, is evidence of the application of current engineering technique to American munitions.

The T-2 model, including as it does outstanding advancements over its predecessor of ten years ago, is a creditable indication of the type of work our Ordnance Department is doing and is also proof of the ever changing nature of ordnance design in its effort to keep abreast of current scientific progress.

A Course In Management

UNDER the American system governing the assignment of officers of the technical branches of our Army no objective is more apparent than that our officers are trained essentially for executive and administrative tasks of an all-embracing nature. This system is quite different from that in vogue in some European countries where oftentimes a young officer upon graduation from a military school is assigned to scientific work in a technical or research establishment where he remains for the entire period of his active service.

While there are defenders and opponents of both systems, what we call the American system has many advantages, not the least of which is that it maintains and develops the broader capabilities of the individual and prevents as far as possible the grooved and routine outlook. This being so, it is of extreme interest to note that at the Ordnance School at the Watertown Arsenal there recently have been put in effect several modifications of the regular course. One of seeming importance is that the organic chemistry course has been somewhat reduced and the time gained has been replaced by chemical engineering. Likewise the course in machine design has been increased while that in ballistics has been reinstated. The most important change, however, and the one which gives rise to our opening remarks, is the modification of the former course in arsenal administration and its replacement with a course in management to include not only the direction of inert things but a very comprehensive study of dealings with the human element. In the new course there will be lectures in pure and applied psychology. The need of such a course has been felt for a long time, not that Ordnance Officers are poor psychologists or poor managers, but, on the contrary, because their normal

military life is so bound up with economic and industrial relations that a training of this nature is quite essential. We should say that the authorities at the Ordnance School have acted wisely in expanding the scope of their instruction to include these necessary features. The Ordnance School rightfully becomes now rather a university since it aims to instill a rounded knowledge of all phases of the duties and responsibilities of its students. Leadership of the man always will be more essential than direction of the machine.

An Echo of Other Days

THE usually staid and occasionally humorous *Congressional Record* contains in its issue of January 17, 1931, the memorable World War address of Senator Carter Glass of Virginia, then a member of the House of Representatives, on February 7, 1918. The oration was resurrected nearly twelve years after its delivery "in view of recent publications relating to the proceedings and transactions in the War Department during the period of the World War."

Aside from the fact that this great address involves many individuals who have long since passed from the stage of public affairs, it is a dispassionate record of the War Department during the early stages of the World War. As a polemic it will live both because of its intrinsic truth and its masterly presentation. It is from such a source as this that the record of American war effort, stripped of personalities, will be obtained by the future historian.

Much has been written of the troubles of the Ordnance Department at the beginning of the World War. The machine gun controversy was, in its day, one of the major topics of concern. Artillery, rifles and ammunition supply were subjects in which everyone had a very commendable interest. Naturally public opinion was divided among friends and foes, the latter talking much but offering little. But with all political considerations cast aside, the fact remains that the great work of the Ordnance Department from the very beginning was surprisingly well done even though the limitations were quite severe. It is not difficult to understand our lack of preparedness in 1917 nor will it be should a similar occasion arise again. It is the duty of the War Department to advise the people through their representatives of the needs of the national defense. One has only to refer to the recommendations presented annually since the very beginning of our country to know that these problems are wholly stated but usually only half remedied. The incontrovertible fact remains that recommendations of the department are not always heeded, and yet in time of emergency the one subject of blame is the very agency which has striven to prevent the cause of it.

If the address of Senator Glass serves no other purpose at this particular time (and there are many historical functions which it will always fill) it is a clarion echo of the difficulties of our national defense agencies against whose positive striving there always seems to be a negative force. Until public opinion reaches the common ground between the extreme militarist and the extreme pacifist and is willing to maintain that position against all odds we cannot be certain that the inadequacies of our national defense will ever be remedied once and for all. It may be that such a state of mind is impossible of attainment in a democracy.

War With Rockets!

THE fantastic lengths and growing intensity to which the methods of future warfare are discussed nowadays is the occasion quite often for the conclusion that war will eventually outgrow itself. The most recent evidence of this kind is contained in an address by Professor Hermann Oberth, Hungarian pioneer in space-rocket flying experiments, who lectured during January at the Vienna Meteorological Institute of Urania, an account of which appeared in the *New York Times*.

Professor Oberth related the results of his twenty years of experimenting with the problems of rockets. His latest missile weighed empty nearly 18 pounds and contained 70 pounds of a secret liquid fuel. The rocket consumed 250 grams of fuel a second, attaining a speed of 8,750 feet per second. While the practical developments of the rocket, according to Professor Oberth, are the analysis of the upper strata of the atmosphere by means of apparatus attached to the rocket, extremely important war-time uses are claimed for the invention. Photographic instruments can be carried on the rocket which the enemy would be unable to shoot down, map-making would be simplified and even objectives on the other side of the earth could be bombarded. Compared with rockets, said Professor Oberth, airplanes will be little more than obsolete scrap iron within a few years.

We are surprised to learn from the Professor's discussion that the great military powers, with the exception of Germany, are feverishly pushing experiments with deadly death rockets. "He himself," says the account, "is experimenting with these possibilities but believes it is really in the nature of pacifistic work since the horrors of warfare, by the methods which it would be possible to employ once the experiments reached a certain stage, by gas rockets, would force the world, in self-protection, to outlaw all war promptly and effectively."

While it is not our purpose to view lightly the claims of any scientific endeavor, it would seem to the casual observer that the day of enemy firing lines on opposite sides of the earth is quite fantastic. New wars are seldom fought with the same implements and methods of their predecessors but, at that, it is a far cry from "the Paris Gun" to "trenches" separated by entire continents.

The Oberth researches serve to emphasize a means of warfare which long since became obsolete. Begun at Woolich more than a century ago when that great institution was directed by General Desaguliers, rocket development progressed under the leadership of William Congreve whose objective was a missile carrying an incendiary or explosive charge with a range of two miles! The development met with considerable success and, in 1805, Sir Sidney Smith's expedition against Boulogne included a number of ships equipped for firing salvos of rockets. Later rocket brigades distinguished themselves at Leipzig (1813) and at Waterloo (1815). "The rockets' red glare" at Fort McHenry served to illumine the Star-Spangled Banner that inspired Key to pen our national anthem. But the breech-loader, the rifled bore and smokeless powder relegated the rocket to the rôle of fireworks and under the more severe term "pyrotechnic" we have it for signal use today. Thus the Oberth rocket would indicate a cyclic return of early principles in the face of more potent practices. But, in this age, the prophet is not only without honor—he is without profit!

A Defense Study of Tremendous Value

An Editorial

NO more significant development in the perfection of our defense plans has occurred in recent years than the study now being undertaken by the commission appointed by Joint Resolution of Congress in June of last year. It will be remembered that the resolution, the title of which is "To Promote Peace and to Equalize the Burdens and to Minimize the Profits of War," was the subject of much debate during its passage through the two houses of Congress. In its final form the resolution provides for a commission to study and consider whether or not the Constitution of the United States should be amended to provide that private property may be taken by Congress for public use during war and to recommend methods of equalizing the burdens and removing the profits of war together with a study of policies to be pursued in the event of war. By the terms of the resolution the commission appointed to make this study shall report definite recommendations to the President for transmittal to the Congress not later than the first Monday in December, 1931. The commission is specifically instructed not to consider and report upon the conscription of labor.

This important body, by the terms of the resolution, is composed of four members of the House of Representatives, four members of the Senate and the Secretaries of War, Navy, Agriculture, Commerce, Labor and the Attorney General.

DURING its first formal meetings which were devoted to the preparation of plans for carrying out the detailed investigations necessary to fulfill its functions, the organization of a secretariat was decided upon to effect coöperative efforts among the heads of the executive departments represented on the commission. These first steps emphasized that the policies and methods to be developed as a result of the commission's study are to apply only in the event of war. Since the first duty of a nation at war is to insure the continuance of its own existence, nothing can be allowed to interfere with the accomplishment of this primary purpose. The tenor of the investigations presupposes, and rightly so, the marshalling of the strength of the nation, for war involves not only military effort but great industrial power as well. Modern warfare consumes daily such a tremendous total of material things that the industrial capacity even of a nation such as ours may well be strained to the utmost. The task of the commission, therefore, has been defined to be "the development of a comprehensive and concrete plan under which the nation's vital needs could be met in war in such a manner that profiteering would be impossible, or at least be reduced to the minimum, and which would require from all citizens and from every material thing contributions in accordance with principles of justice and equity."

The secretariat, under present plans, will consist of nine major sections. The legal section, to be organized under a representative of the Attorney General, will study constitutional and legal matters; the Army section will deal with general estimates of War Department requirements of personnel and material in war; the Navy section, general estimates of the same nature relating to the Navy, and the manpower section to study all questions affecting personnel other than military and naval. Of special importance is the industrial section organized under a representative of the Assistant Secretary of War who, by the terms of the National Defense Act of 1920, has been studying these and related matters for more than ten years. This section will analyze the control of manufacturing facilities, raw materials, transportation, power and allied matters in war. There will also be a war finance section to study the control of finance and capital issues in war, an agricultural section for the investigation of control of foodstuffs and other agricultural products, and a war trade section having to do with the control of foreign and domestic commerce. The organization also provides for the assembly of all sections on a general committee to consider questions of price control, general policy, etc. We repeat, such an exhaustive study by the competent personnel now engaged upon it is frought with extremely valuable results for the national defense.

APROPOS of these developments a recent restatement of the War Department's stand on peace-time legislation to provide for the draft of manpower in war comes at an opportune time. The Secretary of War has said that the Department is not in favor of seeking peace-time legislation to effect the draft of manpower in the event of a grave national emergncy. The principal reasons underlying the Department's stand are:

"A complete mobilization plan for war must contemplate the mobilization or control of every national asset needed to carry the great burdens that war entails. The Veteran organizations of the country have rightly insisted on such a policy. Manpower is only one of the essential elements that go to make up the vast machine necessary to a nation when faced with a grave emergency. To seek piece-meal legislation that would crystallize one portion of the plan into law while the remainder would be subjected to all the changes that might be found desirable before the arrival of an emergency might put the whole machine out of gear."

Thus it appears that these developments will have a stabilizing effect on industrial war planning in that they will present for review the character and progress of our plans and policies thus far. No one theory based on World War experience is more definitely established than that modern war is no longer the sole task of the military authorities. Its ramifications affect every phase of life and every factor of economic production and consumption. To study these all-important questions in the light of experience and from the viewpoint of the divergent factors involved can result only in a decided enhancement of our national defense plan provided, of course, that in the studies themselves the practicality and efficient methods of our national life are not overlooked. We have every reason to hope and believe that they will not be. Rather we will have a valuable analysis of policies after twelve years of serious thought.

Association Affairs

Annual Meeting of Trustees and Directors

THE regular annual meeting of the Trustees and Directors of the Army Ordnance Association was held in the Board Room of the Irving Trust Company, Park Avenue and 42nd Street, New York, N. Y., on January 29, 1931. There were present Benedict Crowell, President; William W. Coleman, Vice President; Frank A. Scott and John C. Jones, Directors; John Ross Delafield, Counsel, Chas. Elliot Warren, Treasurer; and L. A. Codd, Executive Secretary.

The President called the meeting to order and the Executive Secretary was about to read the minutes of the last meeting when, on motion duly made, seconded and carried, the reading of the minutes was dispensed with and they were approved as recorded.

The President announced with regret the death, on July 5, 1930, of Mr. Waldo C. Bryant, a director of the Association since 1919. On motion duly made, seconded and carried, it was unanimously resolved that a committee be appointed to draft resolutions upon the death of Mr. Bryant. The President announced the members of the Committee as follows: James L. Walsh, Chairman; Charles H. Tenney and L. A. Codd.

The President announced the election by general ballot of Maj. Gen. C. C. Williams, U. S. A., Ret., former Chief of Ordnance, to serve as a Director of the Association for a term of four years beginning January 1, 1931.

Brig. Gen. Chas. Elliot Warren, Treasurer, presented his report on the financial condition of the Association. He announced cash balances as of December 31, 1930, of $4,811.71, with no bills payable, and the addition of $2,305.25 to the Investment Account during the year. The securities owned by the Association as of December 31, 1930, had a par value of $32,000, market value of $33,890, and a cost value of $33,672.90. He likewise called attention to the annual audit of the records which was made by Messrs. Ernst & Ernst, certified public accountants, as of December 31, 1930, which declared the accounts of the Association to be correct and in good order. On motion duly made, seconded and carried, it was unanimously resolved that the Treasurer's report be accepted with thanks and approved as rendered.

The annual report of activities and affairs of the Association for the calendar year ended December 31, 1930, was read by the Executive Secretary and was followed by discussion.

The report follows, in part:

"I have the honor to submit the following report of activities and affairs of the Army Ordnance Association for the calendar year ended December 31, 1930, together with statements of the financial condition at that time. I submit also for your approval recommendations in respect of activities for the year 1931.

"Operations during the past year were conducted in accordance with the directive of the Board of Trustees and Directors as approved at their regular annual meeting on January 30, 1930. While the results for the year, considering general business conditions, were encouraging from a financial standpoint, the growth of membership was not proportionate. However, to have maintained the membership exactly throughout the year may possibly be considered satisfactory in view of the general situation.

"With regard to the headquarters offices of the Association, the additional full time of a clerk-stenographer, whose employment was authorized by this Board, was employed during February, and a fidelity bond in the amount of $1,000 was executed in her name. The three employees of the organization are now bonded in ample amounts.

1. Membership

"During 1930 there was no increase in members, neither was there a loss. The membership as of January 1, 1930, was 3440 and exactly that figure on December 31, 1930. The total membership, all classes, as of December 31, 1930, is slightly lower than the total for February, 1930, 3456, the highest membership in the history of the organization.

"The Spruance endowment, established in 1929 by the gift of Col. W. C. Spruance, a Vice-President of the Association, providing for five faculty and five student members in the School of Engineering of Princeton University, which became effective in October, 1929, is functioning satisfactorily. New members, both of the faculty of the school and of the senior students, were nominated by the University officials in October, 1930, in accordance with the terms of the endowment.

"During the year two members were admitted to life membership. There are now ten life members enrolled.

2. Annual Meeting

"The sessions of the Twelfth Annual Meeting of the Association were held October 8th and 9th, 1930, with the Committee on National Defense of the United States Chamber of Commerce participating.

"As in previous years, invitations and preliminary announcements were sent all members and invited guests. Approximately 6,000 invitations were distributed and 8,000 programs were printed.

"In accordance with the plan approved at the last meeting of this Board, two sessions of the Annual Meeting were held, the first a business and technical session in the auditorium of the U. S. Chamber of Commerce Building in Washington on the evening of October 8th. The engineering and scientific session was held the following day, with the approval of the Secretary of War, at the Aberdeen Proving Ground, Maryland, at which it is conservatively estimated 6,000 members and guests were present.

"The attendance at the Washington session was most gratifying and there is every reason to believe that if this plan is continued the importance of a business and technical session held in Washington on the night preceding the Aberdeen session will grow in general interest and value to members as a vehicle for conducting the organizational activities of the Association.

"The attendance at the Aberdeen session was approximately one-half of that of the preceding year. This was due to the fact that strenuous effort was made to restrict attendance.

"The program of demonstrations by the Ordnance Department and other branches of the Army, including a special exhibition by the Air Corps, proved most interesting and instructive. All arrangements connected with the handling of the crowd were admirably made and carried out and reflect great credit upon Lieut. Col. E. M. Shinkle, Commanding Officer of the Proving Ground, and his assistants. The Association is under renewed obligation to the War Department and particularly to Maj. Gen. Samuel Hof, Chief of Ordnance, Colonel Shinkle and the Officers of the Ordnance Department and other branches and services of the Army for their splendid coöperation.

3. Local Posts

"During 1930 one new local post was organized with headquarters at Birmingham, Ala. There are now eleven posts in existence as follows: Birmingham (membership 97), Boston (membership 80), California (membership 151), Chicago (membership 120), Cincinnati (membership 81), Milwaukee (membership 60), New York (membership 319), Philadelphia (membership 260), Pittsburgh (membership 197), St. Louis (membership 85), and Washington (membership 55). The total number of members affiliated with local posts is 1505 or approximately 43½ per cent of the total Association membership of 3440. It is hoped that the coming year will make practicable the organization of other new local posts.

4. ARMY ORDNANCE

"Continued effort was made during the year toward further improvement of ARMY ORDNANCE both as to text matter and typographical arrangement. The average size of the journal was 80 pages and cover, while the average press run was 4500. Six new cover designs obtained from the noted American artist, Mr. Vernon Howe Bailey, the first of which appeared with the January-February, 1930, issue, were used throughout the year.

"Likewise effort was made to improve the quality of articles and discussions published in the Journal. While the costs rose slightly, it is felt that the additional expenditures were well warranted and that the policy of continually improving the Journal as one of the best vehicles for furthering the interests of the organization should be continued.

5. The Williams Medal

"The Board of Directors, acting as a special committee, authorized the foundation of the Williams Gold Medal for Distinguished Ordnance Service and its first award to Maj. Gen. C. C. Williams, Chief of Ordnance 1918-1930, whose name it bears. The first award of the Medal to General Williams was the unanimous decision of the entire Board of Directors.

"The Medal, containing a likeness of General Williams, is the work of a Philadelphia sculptor, Mr. Ruud Fruend. The dies were made and the medal of 14 kt. gold cast by the Bailey, Banks and Biddle Company of Philadelphia. The award of the medal was made to General Williams at the business and technical session of the Twelfth Annual Meeting in the presence of a notable assembly.

6. Trophies

"The Ordnance trophy, a caliber .30 sport type Springfield Rifle, for award to the winner of the President's Match of the National Rifle Matches, was awarded to Sgt. R. L. Speers, Inf., U. S. A.

7. Financial Statement

"The excess of receipts over expenditures with all bills paid was $2,010.86. $2,305.25 was withdrawn from cash and added to the investment account.

"A financial statement of income and expenditures for the year 1930, with comparative totals for the preceeding year, is appended hereto (Table 1, below.) A statement of the resources and liabilities as of December 31, 1930, is also appended (Table 2, page 392).

TABLE 1.

Income Account for Year Ending December 31, 1930.

Source.

Dues:	
Old Members	$11,201.41
New Members	1,783.50
Old Associate Members	6.00
Old Student Members	81.00
New Student Members	40.50
Old Group Members	5,400.00
New Group Members	300.00
Life Members	200.00
Old Subscribers	2,026.03
New Subscribers	697.12
Advertising	5,268.58
Income from Investments	1,710.00
Miscellaneous	159.44
Total	$28,873.58

Expenditure Account for Year Ending December 31, 1930.

Purpose.

ARMY ORDNANCE	$10,889.72
Refunds to Local Posts	781.50
Membership Extension	447.13
Annual Meeting	1,816.53
Rent	1,320.00
Telephone	207.59
Salaries	8,471.72
Office Expense	1,245.32
Postage	509.35
Trophies	83.42
Office Equipment	286.85
Contingencies	803.59
Total	$26,862.72

8. Audit

"An audit of the finances of the Association was made by Messrs. Ernst and Ernst, certified public accountants, as of December 31, 1930. The audit covered the fiscal year 1930, the last previous audit having been made by the same organization as of December 31, 1929. The accounts of the Association were found to be correct and in good order. Certified copies of the Audit Report are available for the information of Officers and Directors.

9. Election of Officers

"In accordance with the Constitution and By-Laws, the biennial election of Officers and Directors was held by

letter ballot, polls closing on the first Monday in September. Likewise in conformity with the Constitution a Nominating Committee was appointed by the President consisting of James L. Walsh, Chairman, A. K. Hamilton, Spencer G. Kuhn, Taylor Allderdice and Bruce Cornwall.

The ballots were canvassed by a committee of whom Mr. A. Y. Leech, Jr., was Chairman, and Capt. J. K. Christmas, Ord. Dept., U. S. A., and Maj. C. E. McRae, Ord. Res., U. S. A., were members. The results of the canvass were the practically unanimous reëlection of the following:

President—to serve two years beginning January 1, 1931 —Benedict Crowell of Cleveland, Ohio.

Vice-Presidents—to serve two years beginning January 1, 1931—William W. Coleman of Milwaukee, Wis., and William C. Spruance of Wilmington, Del.

Directors—to serve four years beginning January 1, 1931 —Samuel McRoberts of New York, N. Y., and Pliny E. Holt of Stockton, Calif. Maj. Gen. C. C. Williams was nominated and unanimously elected a Director for four years beginning January 1, 1931.

11. Budget 1931

"I submit the budget of estimated income and recommended expenditures for the year 1931 for your approval as follows: (Note: Explanatory data in respect of each item are not published due to space limitations.)

(1) Old Members		$11,500.00
	(Income 1930 $11,289.41)	
(2) Old group members		5,000.00
	(Income 1930 $5,400.00)	
(3) New members		1,700.00
	(Income 1930 $1,824.00)	
(4) New group members		1,000.00
	(Income 1930 $300.00)	
(5) Old subscribers		1,700.00
	(Income 1930 $2,026.03)	
(6) New subscribers		300.00
	(Income 1930 $697.12)	
(7) Advertising		6,500.00
	(Income 1930 $5,268.58)	
(8) Interest		1,800.00
	(Income 1930 $1,710.00)	
Total expected income for 1931		$29,500.00
Total income 1930		28,873.58

"The budget of expenditures for 1931 which I recommend for your approval is as follows:

(1) Rent	$ 1,320.00
(2) Office expense	1,600.00
(3) Salaries	8,900.00
(4) Postage	1,000.00
(5) Annual Meeting	2,000.00
(6) Extension	600.00
(7) Office equipment	200.00
(8) Post refunds	800.00
(9) Contingencies	800.00
(10) Trophies	100.00
(11) ARMY ORDNANCE	11,180.00
Total recommended expenditure	$28,500.00
(Total expenditures 1930 $26,862.72)	

12. Recommendations

"While the recommended budget of expenditures is based upon a fair estimate of income, I believe that it will be ample to maintain the steady progress of the organization. An increase in membership is the principal objective. While it may be somewhat difficult to secure any great increase in members during 1931, extension activities for new members and ways and means of retaining old members are the most important considerations. To attain these ends I suggest: (1) Intensive campaigning for new members; (2) The formation of new local posts wherever there is sufficient local interest; (3) The consideration of possible sources of endowments, similar to the Spruance Endowment, for memberships in schools and colleges; (4) The continued improvement of the sessions of our annual meeting particularly our Washington session even to the extent of inviting some world renowned figure as the principal speaker; (5) The continued improvement of our journal, ARMY ORDNANCE.

TABLE 2

Balance Sheet
Army Ordnance Association

Assets

	1930	1929	1928
Cash on hand	$ 15.00	$ 15.00	$ 2.69
Cash on deposit:			
Association Account	1,538.65	2,846.13	5,811.28
Magazine Account	3,273.06	2,208.08	3,252.43
Demonstration Fund	12.84	101.58	400.00
Cash on hand for deposit	36.85		
Accounts receivable:			
Due from advertising	377.50	65.00	90.00
Other Assets:			
Securities owned	*33,672.90	**31,367.65	***21,939.85
Postage	181.88	225.74	73.14
Permanent:			
Furniture, fixtures and supplies	1.00	1.00	1.00
	$39,109.68	$36,830.18	$31,570.39

Liabilities

Unearned income:			
Prepaid membership dues	$ 9,706.31	$ 9,948.48	$ 9,816.92
Prepaid subscriptions to magazine	1,036.60	812.25	756.00
Reserve:			
Endowment reserve	822.50	822.50	
Life member reserve	1,000.00	800.00	
Operating reserve	26,544.27	24,446.95	20,997.47
	$39,109.68	$36,830.18	$31,570.39

*Cost. Market value December 31, 1930, $33,890.00.
**Cost. Market value December 31, 1929, $31,412.30.
***Cost. Market value December 31, 1928, $22,243.80.

13. Conclusion

"Without the splendid coöperation of our Trustees and Directors, which has marked their service for many years, the functions of the executive office could not be carried on nearly as smoothly and, I hope, as beneficially as they have been since the very beginning. Likewise, the interest and keen desire of General Hof and every officer of the Ordnance Department without exception are responsible in large measure for whatever of real service our organization is to the National Defense. With the continuance of these valued relationships the future assures a larger, stronger and more effective role for our Association, the need for which increases as the industrial preparedness lessons of the World War pass further into the past."

On motion duly made, seconded and carried, it was unanimously resolved that the Executive Secretary's report be accepted with thanks and approved as rendered.

While explaining certain details of the authorized expenditure budget for 1931, the Executive Secretary emphasized that the item entitled "Contingencies" is for miscellaneous expenditures not properly chargeable to other accounts of the budget. No provision is made for expenses of officers and directors. These, in every case since the establishment of the organization thirteen years ago, are always borne individually by the officers and directors themselves. Not only do they serve without remuneration, but in no case have they ever permitted or accepted reimbursement for their actual expenditures incident to Association business.

The Secretary was directed to make special study and report on ways and means by which to increase the effeciveness of local posts of the organization.

The President then called attention to that portion of the report of the Executive Secretary concerning the election of officers and directors which was held during September, 1930. Under the Constitution of the Association, Article IV, Section 2, the Treasurer, Counsel nad Executive Secretary are appointed biennially by the Board of Trustees. On motion duly made, seconded and carried, it was unanimously resolved to reappoint with expressions of thanks Gen. Chas. Elliot Warren, Treasurer; Gen. John Ross Delafield, Counsel; and Maj. L. A. Codd, Executive Secretary, for two years ending December 31, 1932.

The next subject for determination was the date and place of the thirteenth annual meeting of the Association. The President suggested that the meeting be held as in 1930; namely, with two sessions, a business and technical session in Washington on the night preceding the Aberdeen demonstrations, and the technical and scientific session at the Aberdeen Proving Ground, Md. On motion duly made, seconded and carried, it was unanimously resolved that the Aberdeen session of the annual meeting be held, with the approval of the Secretary of War, at the Aberdeen Proving Ground, Thursday, October 8, 1931, and that the National Industrial Conference Board be invited to participate in the meeting.

The Executive Secretary then outlined recent activities of certain commercial promoters and Army Officers looking toward the affiliation of all so-called service organizations and their publications. He explained that while no definite proposal had been tendered the Army Ordnance Association, he had opposed informally such affiliation with service organizations in so far as the Army Ordnance Association is concerned. On motion duly made, seconded and carried, it was unanimously resolved that the action of the Executive Secretary be confirmed. It was the sense of the meeting that the Association does not look with favor upon affiliation with any service organization representing the combatant arms, nor does it desire to be included in any current plans which have as their purpose the affiliation of editorial policies, the syndication of articles, etc. The Association will coöperate at all times with service organizations and their publications. However, since its particular objective is the advancement of industrial preparedness, its membership almost 90 per cent civilian and its scope technical and scientific, it will continue its operations and the policies of its Journal as they have been conducted since its organization.

Following the meeting the officers attended luncheon arranged by General Warren at the Army and Navy Club at which Colonel Brown, President of the Club, was an honored guest.

Washington Post

THE first meeting of the Washington Post for the year 1931 was held at the Army and Navy Country Club, Washington, D. C., Friday, January 30th at 12:30 P. M. Officers of the Field Artillery stationed in Washington were invited to attend.

The post was particularly fortunate in having as honor guests at the luncheon the Assistant Secretary of War, Col. Frederick H. Payne; Maj. Gen. Samuel Hof, Chief of Ordnance, U. S. Army; and Brig. Gen. Benedict Crowell, President of the Army Ordnance Association. The principal speaker was Maj. Gen. William Crozier, U. S. A., Ret., former Chief of Ordnance. Lt. Col. Charles G. Mettler, President of the Post, presided.

Having spent a number of years in China following the World War, General Crozier is conversant with the economic and political developments in that country in recent years and is particularly equipped to discuss the progress and types of armament used by the Chinese forces. The General, who was Chief of Ordnance of the Army for eighteen years, having retired in January, 1918, fascinated his hearers with the remarkable account of developments in China of which he was an observer.

The meeting was largely attended and bespeaks additional praise for the President and officials of the Post who have, during the past year, added such interest to the activities of the local organization.

New Members

THE following were admitted to membership in the Association since the last issue of ARMY ORDNANCE: Wm. P. B. Blackwell, Jr., Chicago, Ill.; R. C. Brower, Canton, Ohio; C. D. Fleming, Cleveland, Ohio; W. E. Grainger, Sparrows Point, Md.; William B. Hannum, Paoli, Pa.; J. G. Heaslet, Cleveland, Ohio; G. A. Hettle, Bethlehem, Pa.; C. W. Kaufman, Bethlehem, Pa.; P. P. Kearney, Cleveland, Ohio; E. G. Kegler, York, Pa.; Fred Key, St. Louis, Mo.; A. H. Lauer, Granite City, Ill.; Douglas G. Ludlam, Aberdeen, Md.; E. P. Lynch, St. Louis, Mo.; W. E. Miles, Cleveland, Ohio; C. E. Mundorff, Cleveland, Ohio; R. H. Raring, Harrisburg, Pa.; Joseph L. Rehme, St. Louis, Mo.; August Rimelspacher, Newark, N. J.; F. H. Stephens, Cleveland, Ohio; Erwin P. Stupp, St. Louis, Mo.; Norman J. Stupp, St. Louis, Mo.; John W. Thomsen, St. Louis, Mo.; David M. Williams, Godwin, N. C.; Louis B. Wilson, Rochester, Minn., and A. O. Woerner, St. Louis, Mo.

Necrology

SINCE publication of the last issue of ARMY ORDNANCE, notice has been received of the death of Messrs. W. S. Griffiths, Norristown, Pa.; Thomas B. Lashar, Fairfield, Conn.; Philip P. Quayle, Kings Mills, Ohio, and Alfred Wagstaff, New York, N. Y. On behalf of the Army Ordnance Association condolences are extended to the relatives and friends of these gentlemen.

Association Membership

The following extracts from the Constitution and By-Laws of the Association define the several classes of membership.

"SEC. 1. Full membership in the Association shall be open to all men who are American citizens and who are interested in promoting the cause of industrial preparedness, particularly in connection with the design, procurement, production, manufacture, inspection, test or supply of ordnance material.

"SEC. 3. Student membership in the Association shall be open to all men who are American citizens and who are students in technical schools or colleges. Student members shall not vote or hold office in the association."

Professional Notes

The Use of Welded Construction in Ordnance Manufacture

DURING the past few years considerable effort has been directed by the Ordnance Department of the Army to the development of welded construction to replace riveted construction with a view to weight and cost reduction both in commercial and ordnance design of various weapons. There has been a constant attempt to reduce weight in construction without jeopardizing strength and safety. Considerable thought and ingenuity have been expended to a point where welding construction is considered to have a permanent place in production, and welding activities have become a considerable part of the manufacturing activity of the Watertown and Rock Island Arsenals. When it became apparent that welded construction was to play an important rôle in manufacture, a thorough study of the fundamentals involved proved that trained personnel and proper equipment and working conditions must be provided, so that production costs could be kept down and quality and uniformity of workmanship maintained. Personnel of the arsenals made, and are making, tours of duty at commercial plants to study processes and equipment with the result that the most modern methods and equipment are now in use at the Ordnance manufacturing establishments.

At Rock Island the equipment includes electric arc-welding and atomic hydrogen welding apparatus, an automatic shape-cutting machine, and other correlated apparatus. The automatic arc-welding machine is capable of welding straight line seams up to 16 feet in length, and is adapted for maintaining special fixtures for practically any type of work which can be welded on an automatic welder. The equipment includes various portable units for work where jobs are too heavy to be moved readily.

Where arc welding is unsuitable, an atomic hydrogen welding unit is available. The automatic shape-cutting machine permits use of a permanent template for continuous reproduction of the same shape. Inexpensive templates of wood or cardboard may be used where economy dictates. This machine is equipped with a circular cutting attachment capable of cutting circles up to 40 inches in diameter.

Ordnance Reserve Courses At University of Michigan

ARRANGEMENTS have just been completed with Dr. Alexander G. Ruthven, President of the University of Michigan, Ann Arbor, to conduct a two weeks' course of training for reserve officers of the Ordnance Department in August, 1931. The faculty of the University will be able to furnish sufficient Ordnance reserve officers to carry on the instruction. Col. A. H. White, Ord. Res., will be in charge. It is proposed to train between thirty and forty Ordnance reserve officers, preferably those assigned to the districts and arsenals of the mid-West. The course will include inspection of ammunition, explosives, artillery carriages and the raw materials used therein. In addition, officers who may later be assigned to loading plants, will be able to receive a course of instruction outlining their duties, from the Department of Chemical Engineering of the University.

The establishment of this training center at the University of Michigan brings the number of Ordnance training schools to three. The one at Stanford University in California has been in existance for several years and the Massachusetts Institute of Technology last summer inaugurated a similar course with great success.

In addition to the peace-time training, it is proposed that in case of an emergency these three universities be used as Ordnance training centers. Their establishment in peace-time will greatly facilitate the beginning of their operation in time of war.

The Navy Tests the Autogiro

ASSISTANT Secretary of the Navy for Aeronautics, David S. Ingalls, announced recently that the Navy has purchased a Pitcairn autogiro to test its possibilities as an observation plane for naval purposes.

Expressing himself as "intensely interested" in all aviation developments and achievements, Mr. Ingalls stated, "I consider the development of the autogiro of great importance to aviation and therefore have been very desirous of obtaining one for the Navy."

The nature of the tests for the new plane, which will assume the Navy's classification as an XOP-1, first will include experiments looking towards its use in small landing spaces and clearings on land. Officials in the Bureau of Aeronautics, Navy Department, point out that the small spaces available for the landing and taking off of Marine Corps planes in Nicaragua have often endangered the lives of aviators as well as handicapping plane operations.

It is the present intention of the Bureau to extend the experiments to landings aboard the U. S. S. LANGLEY, second line aircraft carrier which will base on the Atlantic coast following the fleet concentration.

The Pitcairn autogiro has a specified weight of 2,807 pounds, and is a two-seater. Engined with a 300-horsepower Wright J-6 motor, the plane has a designed speed of 123 miles an hour, and its designers claim a four-hour endurance at economical speed. Its designed ceiling is 16,400 feet.

Ammunition Renovation Plants

THE renovation plant for 75-mm. high explosive shell at Raritan Arsenal, Metuchen, N. J., is again in operation. This plant was closed for several months pending the accumulation of additional stocks of unserviceable shell. The

new renovation plant at Curtis Bay has begun operation. This plant will renovate 75-mm. shrapnel at the rate of 300,000 a year. There are large stocks of unserviceable shrapnel on hand at Curtis Bay awaiting renovation. The 21-second time fuzes will be renovated at Pictinny Arsenal. The new plant for 75-mm. shell at Nansemond Depot is also beginning operations and will have a rate of 210,000 a year. When all plants are in full production the capacity of the four H. E. shell renovation plants in the United States will be 840,000 a year. One overseas plant in Hawaii has an additional capacity of 100,000, so that the total shell capacity will be 940,000 rounds in the fiscal year 1932, which, with the shrapnel capacity at Curtis Bay, will provide a total capacity of 1,240,000 rounds.

Repairs and Improvements at Ordnance Establishments

UNDER the First Deficiency Act recently passed by Congress the Ordnance Department of the Army received $471,005, for the repair and improvement of arsenals and depots. The funds will be spent at the following stations:

Augusta Ordnance Depot, Augusta, Georgia	$ 11,100
Benicia Arsenal, Benicia, California	7,265
Charleston Ordnance Depot, Charleston, South Carolina	4,000
Curtis Bay Ordnance Depot, Curtis Bay, Maryland	4,730
Delaware Ordnance Depot, Pedricktown, New Jersey	14,100
Erie Ordnance Depot, La Carne, Ohio	23,300
Nansemond Ordnance Depot, Portsmouth, Virginia	16,264
Raritan Arsenal, Metuchen, New Jersey	203,972
San Antonio Arsenal, San Antonio, Texas	3,000
Savanna Ordnance Depot, Savanna, Illinois	43,069
Aberdeen Proving Ground, Aberdeen, Maryland	29,780
Picatinny Arsenal, Dover, New Jersey	42,000
Watertown Arsenal, Watertown, Massachusetts	12,800
Watervliet Arsenal, Watervliet, New York	10,600
Springfield Armory, Springfield, Massachusetts	9,400
Frankford Arsenal, Philadelphia, Pennsylvania	20,000
Rock Island Arsenal, Rock Island, Illinois	15,625
Total	$471,005

In addition to aiding the employment situation, these funds will permit accomplishment of part of the repairs and improvements needed to buildings, roads, and other facilities at these establishments which it has been impossible to perform heretofore. No manufacture of ordnance material is involved, the funds being appropriated solely for repairs and maintenance of facilities.

Improvement in Landing Gear of Navy Planes

DEVELOPMENT of landing apparatus which will make it possible to use all types of service planes either as land or seaplanes has been a major objective of naval technical research for several years, and continuous improvement in recent months indicates the goal will be achieved in the near future.

Amphibious landing gear for observation planes will increase the cost of these aircraft. Landing equipment of this character is being constructed by three manufacturers—Chance Vought Corporation, Brewster & Co., Inc., and Grumman Aircraft Engineering Corporation.

Equipped with landing gear of this character, fleet-based aircraft would be safer in over-water operations, squadrons could be transferred from carriers to cruisers or battleships upon short notice, the range of operations would be increased, and greater mobility, the principal aim of the Navy under the new naval air operating policy, would be brought about for immediate tactical and strategic application.

The principal objection in the past to use of amphibious landing equipment has been the weight factor which has affected adversely the performance of planes on which the gear has been installed. Trials on planes with the fleet have been conducted with a view to "getting the bugs out" and opening the way to more universal use of such devices.

Practically all of the three sets of equipment comprise pontoons to which wheels are attached. The current practice of the Navy is to interchange pontoons with wheels when changes of assignment from carriers and land stations to cruisers and battleships have been carried out.

One of the apparent advantages expected to prove of greatest value is that amphibious planes attached to cruisers or battleships can be dispatched for observation during an attack, remain aloft as long as the fuel supply warrants, and return to carriers for refueling. Under present circumstances, these squadrons are composed of seaplanes which are catapulted from the decks and which cannot effect landings aboard carriers with the fleet.

Greater safety in over-water operations will result because of the advantages this equipment contains which are lacking in the present flotation gear. Should a carrier-based plane be forced to make an emergency landing on the water, the pilot is required to inflate his flotation gear in a short time to prevent sinking. Lack of time to prepare such planes for safe landing on the surface of the sea is noted particularly when accidents occur during take-off from carriers.

Valuable Lincolniana

IN a recent issue, our esteemed contemporary, *The Army and Navy Journal,* recalls the fact that stored away in the files of the Judge Advocate General of the Army are relics of the shooting of President Lincoln more interesting than those possessed by any museum. Under the custody of Mr. E. P. Pitts, chief clerk of the Judge Advocate General's Department, there is an ancient safe containing the exhibits collected for the trial of the conspirators. There is the gun used by Booth to shoot Lincoln—a small, highly decorated, gold bound, muzzle-loading pistol—the lead bullet which killed the President and the probe with which the bullet was located.

In another box, stored in the sub-basement of the State, War and Navy building, are the other exhibits, including the gun which was reputed to have shot Booth, Booth's knife with which he slashed Colonel Rathbone, who was with Lincoln, Booth's saddle, the compass with which he guided his boat down the Potomac river, and many other interesting and invaluable exhibits.

Under the law these exhibits must be kept as part of the files of the Judge Advocate General's Department. Congress should authorize the War Department to turn these venerable relics over to the National Museum. We second most emphatically this suggestion of the *Journal.*

Ordnance Equipment of the Mechanized Force

THE Mechanized Force of the Army will eventually be equipped with over 36 experimental ordnance vehicles, of many different types; the maintenance of which by the ordnance personnel of the Force is a large problem in ad-

dition to the maintenance of the standard ordnance equipment. The 19th Ordnance Company of the Mechanized Force is also maintaining the Quartermaster motor vehicles with which the organization is equipped.

The Ordnance Department has requested the procurement of two experimental armored wheeled infantry carriers, T2. These vehicles are intended for delivery to the Mechanized Force for a tactical test in comparison with two convertible carriers now under development.

In connection with the development of prime movers of higher speeds than are now available, the Chief of Field Artillery requested that the development of tracklaying and convertible type prime movers for division and accompanying artillery be undertaken. The outline specifications furnished indicate vehicles capable of speeds of 20 miles per hour on tracks and 30 miles per hour on wheels, overall dimensions to be not greater than 12 feet long, 6 feet wide, 4 feet high; towing capacity 3 tons on a single axle. Since a vehicle embodying the convertible principle is being developed for the Cavalry, the recommendation has been made that any development work undertaken in the immediate future be confined to the full tracklaying type. Further development of the track development chassis T2 is contemplated to produce the full track vehicle desired.

Proposed Restriction of Power to Declare War

WHILE the House of Representatives was considering the Naval appropriation bill February 11, Representative Frear announced he had introduced two resolutions, H. J. Res. 499, amending the Constitution to limit the powers of the Federal Government in time of war and in declaring war, and H. J. Res. 498, authorizing the President to call a conference of foreign governments. The House concluded general debate on the bill before reaching the amendments.

Under the first resolution, Congress would have the power to provide for forced military service only on the North American continent, when public safety demands it. The resolution also would invest in Congress the power to declare war only after the proposition has been approved by special or general elections of the various States.

Agreements relative to the sale of armaments or the rendering of military aid to warring nations, as well as other international agreements, would be sought at the conference which the President would be authorized to call under Mr. Frear's second resolution.

The resolution relating to the proposed Constitutional amendment is as follows:

"Congress shall have power to declare war only after the proposition shall have been submitted by the President to the several States and a majority of the States at general or special elections called by the Governors thereof, shall have approved the same. This amendment shall not be construed to prevent the President from using the Army and Navy to suppress insurrections and to repel invasions.

"The right of the people to be secure in their persons shall not be violated by conscription or forced military service but when public safety demands, Congress may provide for forced military service on the North American Continent and in no other place."

It is understood that both resolutions will be given thorough study by the appropriate committees of the next Congress.

A Booklet on Aberdeen

ABERDEEN Proving Ground is the title of a very attractive pamphlet published in response to requests from various sources on the history and present activities of the great ordnance testing station on the headwaters of Chesapeake Bay. Well illustrated and attractively printed and bound, this booklet will serve the valuable purpose of furnishing general information about Aberdeen, its staff and organization.

It includes descriptions of the work carried on in the entire establishment with special emphasis on the Gun Testing and the Automotive Testing Division. Chapters are devoted to "Activities of other Branches," "The Coast Artilleryman's viewpoint," "The Field Artilleryman speaks," "The Infantry viewpoint," "Technical and Auxiliary sections," "The Ordnance Depot," "Summer camps" and "The Soldier's Point of view."

No more fitting and well-deserved dedication of the little volume could be made than that which appears on its first page. "Inscribed to Lieutenant Colonel Shinkle who holds so completely the respect and esteem of his command."

Ordnance Reserve Officers in the British Army

A RECENT announcement of the British War Office that there are vacancies for commissions in the Supplementary Reserve of Officers as ordnance mechanical engineers in the Royal Army Ordnance Corps serves to emphasize the differences in methods of recruitment of the English and American systems. In addition to qualifications as to character, medical fitness, nationality, etc., candidates for this British service must be under 30 years of age for appointment as subalterns, and under 35 for appointment as captains, and must also be fully qualified mechanical engineers. Preference will be given to Bachelors of Science (Engr.) Whitworth Scholars, graduates and associates of the institutions of civil, mechanical or electrical engineers.

Candidates will not be required to undergo training in peacetime, but will be liable to be called out on service when the Army Reserve or any part of it is called out by proclamation, and to serve in any part of the world. In return for their obligation, officers will be granted an annual gratuity of £25, payable in arrear. When called out on service, they will receive the rates of pay and allowances applicable to officers holding similar appointments in the regular army, and in addition will receive an outfit grant of such amount and under such conditions as it may be decided to issue to officers commissioned temporarily during the emergency.

Chemical Warfare Progress

THE 1930 annual report of Maj. Gen. H. L. Gilchrist, Chief of the Chemical Warfare Service, U. S. Army, contained an interesting resumé of recent developments from which the following extracts are published:

"Somewhat over a year ago the Technical Division at Edgewood Arsenal, in which all research and development is carried out, was reorganized. The reorganization has proved extremely effective; better coördination has been achieved together with economy of time, money and effort. We are particularly fortunate in having in the controlling

positions in the Research Divisions men of high scientific attainments. Under the new system these scientists have been able to raise the whole plane of our research work to even a higher standard than before.

"The continued interest of the American Chemical Society, the chemical industry, and professional and scientific men of the highest type, has been of great assistance in the technical work of the Service throughout the year.

"Research on any large scale is still comparatively new in our Army. Its importance to the whole scheme of national defense cannot, however, be overestimated. It is possible that our whole national security may stand or fall upon the work achieved in the Edgewood laboratories.

"Our present gas mask is believed to be the best military mask in the world, but its weight and bulk are still greater for foot troops than is desirable. This is fully realized and every effort is being made to provide a lighter and smaller mask which will not sacrifice those qualifications found to be necessary.

"The improved diaphragm gas mask embodying the universal size face-piece, screw type eye-piece assembly, sunproof hose tube without stockinette, hose tube clamp, and a lighter diaphragm assembly with improved sound transmitting properties, has reached the specification stage. Industry is now being canvassed for the most satisfactory forms of manufacture of this diaphragm assembly.

"The development of gas masks suitable for voice transmission for use with optical instruments such as range finders, field glasses and periscopes, is nearing completion. This mask has a special molded rubber face-piece and is assembled to a canister placed at the back of the head. The mask is comfortable and fits well, and has so far given satisfactory performance in so far as voice transmission and vision are concerned.

"Development has been completed and a specification has been prepared for an improved gas mask repair kit which includes several newly developed tools which facilitate repairs.

"A first aid kit for the treatment of gas casualties in and about manufacturing plants for chemical agents has been made up and has been approved by the Chemical Warfare Board.

"Work on smoke screens for protecting large areas has continued throughout the year, and the definite application of such screens to certain areas will be thoroughly tested during the coming year. Recent comprehensive War Department instructions will permit greater coördinated work on this project than has been the case heretofore.

"In cöperation with the Medical Corps, regulations were drawn up for the storage of photographic x-ray film in accordance with a directive from the Secretary of War. Following the completion of these regulations and their submission to the War Department, it was decided that they should cover all photographic film, and the Chemical Warfare Service was directed to prepare a comprehensive draft, coördinating with the Signal Corps and other War Department agencies handling such material. This draft was prepared and submitted to the Signal Corps, Medical Corps and Air Corps for coördination.

"The manufacturing and supply functions of the Service cover the supervision and control of its business activities, including the preparation of the regular annual estimates.

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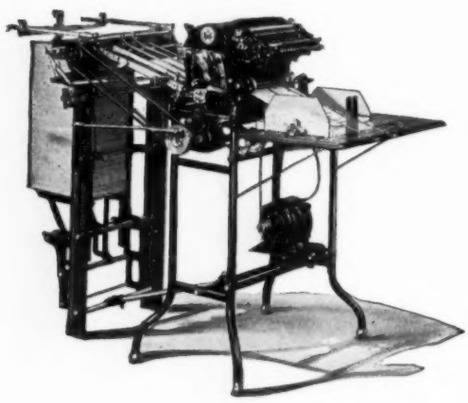

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Book Reviews

SINCE THEN. THE DISTURBING STORY OF THE WORLD AT PEACE. By Sir Philip Gibbs. New York: Harper & Brothers, 1930. $3.75.

THE twelve years since the signing of the Armistice have been years of disillusionment to both the victors and the vanquished of the World War. Peace in Europe has been constantly threatened since 1918. The post-war mind has undergone astonishing and rapid changes in all countries.

Sir Philip Gibbs analyzes in this book the social, economic, and political causes of this disillusionment and the changes in mental attitude. He explains the reasons that have made Spengler's Philosophy of Pessimism and his thesis of a doomed western civilization so popular in Germany. From personal observation in Russia, Italy, Austria and the other countries that participated in the World War, the author has written a fascinating narrative clarifying the present status of European relations as well as the situation of our own country. It would be difficult to find a clearer exposition of post-war trends than that given by Sir Philip Gibbs in this unusually interesting book.

GRAPHIC METHODS FOR PRESENTING BUSINESS STATISTICS. By John R. Riggleman, M. B. A. New York. McGraw-Hill Book Co., Inc. 1930. $2.50.

THE function of graphic methods is to "make statistics talk." The exposition of the rules and conventions of graphics prepared by Professor Riggleman in this compact volume of 231 pages provides a most useful description of the best available methods of chart construction. Both the mechanics of construction and the explanation of the applications of modern statistical charts are well described.

In discussing the task of drawing statistical charts and considering the usual methods of comparing size or comparing historical time series and the other forms of graphic presentation, the author does not merely content himself with showing an effective method but carefully points out incorrect practice and means of avoiding confusion. By means of many illustrations, the principles of preparing and using graphic charts are clarified and are readily understood by a reader with but little technical training.

CAESAR: THE MAN. By Mirko Jelusich. Translated by Bernard Miall. New York. Richard B. Smith. 1930. $3.00.

THE serious reader will not find in this new biography of Caesar evidence of much original research or documentation. In fact certain well known historical episodes in Caesar's life have been altered to conform with the author's conception of a rather idealized Roman citizen.

It is evident that the German author of this fictionalized biography had in mind social conditions in many European countries today with the actual or potential overthrow of representative government. As an entertaining picture of

Caesar and his epoch the book has some merit. It is interesting moreover as an interpretation of Caesar in the light of twentieth century standards.

THE TECHNIQUE OF EXECUTIVE CONTROL. By Erwin H. Schell, Third Edition. New York: McGraw-Hill Book Company, Inc. 1930. $2.00.

DEFINING an executive as "one who is responsible for the execution of work performed by others," the author suggests ways and means of developing an executive method. For a successful executive certain traits such as interest in people, power of personality and a scientific trend of mind are essential. Such qualities as enthusiasm, cheerfulness, calmness, consistency, etc. when reflected in action have great influence on subordinates, and should be studied to improve one's ability as an executive.

The methods of appealing to the will of subordinates through instinctive responses are carefully scrutinized. The final chapters of the manual analyze the various kinds of difficulties executives must face in their relations with subordinates and superiors and offer constructive recommendations in handling them.

Professor Schell has sought to stimulate reflection by interposing questions in the text. Solutions of these practical issues train the mind in solving the problems that occur daily and add to the effectiveness of this provocative study of developing executive ability.

THE NATIONAL FLAG. By Willis Fletcher Johnson. Boston: Houghton Mifflin Company. 1930. $2.00.

THE author undertook the publication of this interesting book on the theory that so much of hearsay and contradictory evidence having appeared on the history and origin of the stars and stripes there would be little fear of his book containing worse errors, while there might be a possibility of its correcting others. He admits that the correction of error is often an ungracious if not an odious performance, "especially when the errors exist in long-cherished traditions, strengthened by local pride or ancestral devotion." With such a difficult subject he has presented a very worthy investigation.

His analysis begins with the coming of the colors during the War for American Independence. He traces the development from the Saint George's cross and the Union Jack and proceeds to discuss various colonial and early battle flags.

Possibly this reviewer is among those affected by long-cherished traditions, and the reading of the author's paragraph on the Betsy Ross flag comes as something of a shock to one who has followed the tradition quite closely. Nevertheless the historical data on this subject, in the analysis of the author, seems to have much definite data wanting, and we are constrained to admit its inaccuracies.

In a day when interest in the flag as a symbol of our nation and its ideals is assailed from many quarters we recommend most highly this text for young and old alike.

ANALYSIS OF INDUSTRIAL SECURITIES. By Carl Kraft and Louis P. Starkweather, M. B. A. New York: The Ronald Press Co. 1930. $5.00.

THE prospective investor, in a chastened mood, is far more inclined to buy securities now in consequence of a reasoned analysis than as a result of tips or hunches. This

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analytic process is difficult, however, as the estimate of the merits of industrial securities is no easy matter. This very valuable book points the way to a method of analysis that is sound and certainly to be recommended if the possibilities of loss are to be minimized.

Financial statements are the principal sources of information considered, and the discussion of the ways of discovering their significance are particularly illuminating. Field work, including a study of plant, management, products, etc., providing a method of exhaustive analysis of an industrial organization, is described in sufficient detail. The value of the book is enhanced by illustrative analysis of going concerns, most of which are well known.

Social Psychology of International Conduct. By George M. Stratton. New York: D. Appleton & Co. 1930. $3.00.

ACCORDING to Professor Stratton the probability of recourse to war can be diminished through the three channels: science, education and politics. His book goes far to provide the scientific background showing the psychological bases of international conduct. In a most effective style, the author describes the significance of racial differences and prejudices, the meaning of nationalism and the forces engendered by it, the causes of differences between nations and the psychological causes of war.

Professor Stratton's illuminating analysis of these elements in international relations is followed by constructive suggestions for the better control of the forces he has described. The book is an impressive contribution to a more satisfactory understanding of international conduct and, in the desirable process of education in this field, will be a useful text-book to aid international understanding.

The New Way of Designing and Building Gas Lines. Technical Bulletin of A. O. Smith Corporation, Milwaukee, Wis. 1930.

MR. W. R. KEPLER, Assistant Chief Engineer of the A. O. Smith Corporation, presents in this brochure published by the company some very enlightening facts and figures on the costs and methods of constructing pipe lines. He presents the final results of an exhaustive and lengthy mathematical study made by himself and associated engineers of his department. The assumptions, method of approach and conclusions are briefly stated to assist in the proper use of the various graphs, charts and curves.

The Autogiro. Brochure of the Pitcairn-Cierva Autogiro Company of America. Philadelphia. 1930.

THIS pamphlet is the first complete authoritative presentation of the autogiro—what it is, what it does and how it does it. It presents something of the history of the autogiro development, its theory and its place in contemporary and future aviation together with a brief review of the work of the organization sponsoring its introduction and licensing in this country.

The engineering supplement to the brochure is particularly enlightening since the secret of the success of the autogiro is in large measure due to the fact that the rotor blades are attached to the rotor hub by means of articulating joints. Readers will find the mathematical analyses of the various forces and the facts of the entire mechanism of this newcomer in the sky of special interest.